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PHYSICS ABSTRACTS

SECTION A

of

SCIENCE ABSTRACTS

SECTION A, PHYSICS

SECTION B, ELECTRICAL ENGINEERING

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ABSTRACTS 3781–4549

VOLUME 56 **JUNE 1953** NUMBER 666

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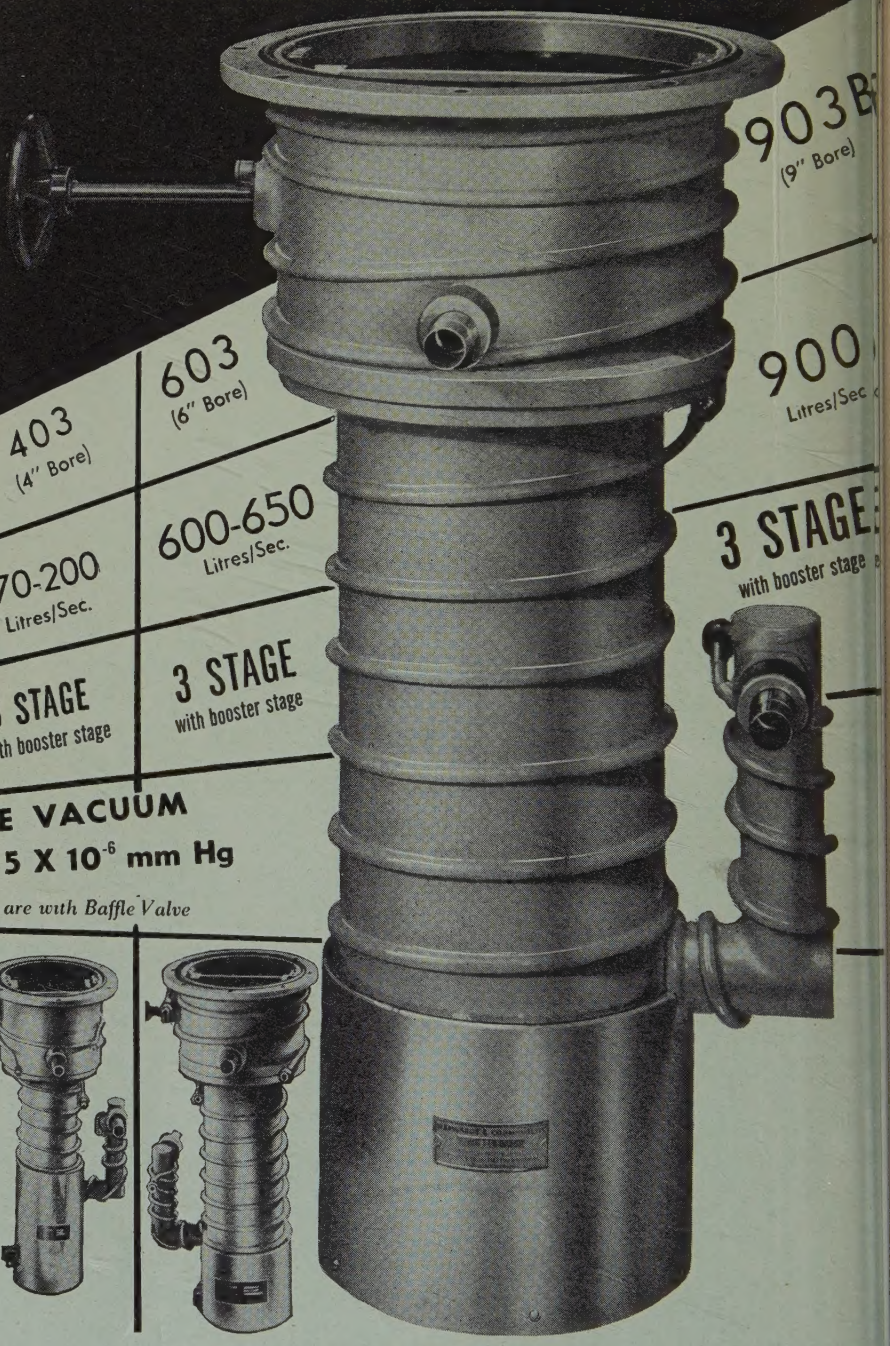

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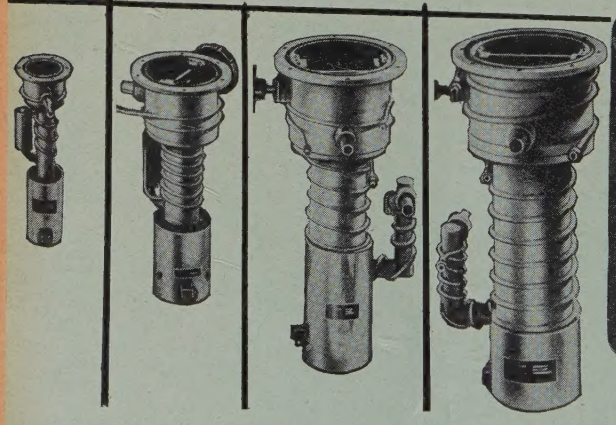

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RELATED SUBJECTS CONTAINED IN SECTION B (ELECTRICAL ENGINEERING ABSTRACTS)

Electrical and magnetic measurements and instruments
Electronic relays and counters
Automatic control mechanisms
Applied electrochemistry
Photocells
Thermionic tubes
Cathode-ray tubes
X-ray tubes
Amplifiers
Radiocommunication
Mechanical engineering
Illumination

LIST OF JOURNALS

The following list supplements the List of Journals published with the January number of Volume 56 (1953). Reprints of the List of Journals can be obtained from the Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s. 0d. post free.

The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

Electro-Magazine	*Electro-Magazine.* 40 Rue du Colisée, Paris (8e).
Instn Engrs Australia Proc. Engng Conf. Melbourne	*Proceedings of the Engineering Conference, Melbourne,* 1953. The Institution of Engineers, Australia. Science House, Gloucester and Essex Streets, Sydney.
J. Meteorol. Soc. Japan	*Journal of the Meteorological Society of Japan.* [Abstracted by *Meteorological Abstracts.*]
Mém. Soc. Phys. Hist. Nat. Genève	*Mémoires de la Société de Physique et d'Histoire Naturelle de Genève.* Bibliothèque Publique des Bastions, Geneva.
Nimbus	*Nimbus.* Sociedad Meteorológica de Bolivia. Presbitero Medina No. 350, La Paz.
Rev. Ingen. [*Montevideo*]	*Revista de Ingenieria.* Asociación de Ingenieros del Uruguay. Agraciada 1464, Piso 14, Montevideo.
Vestnik Akad. Nauk SSSR	*Vestnik Akademii Nauk SSSR.* Cherkasski per 2, Moscow.

Notes

Izvestiya Akademii Nauk, SSSR, Seriya Geograficheskaya Geofizicheskaya. As from No. 2, 1951, this journal is published in separate series, *Seriya Geograficheskaya* and *Seriya Geofizicheskaya.*

New Journals

Doshisha Engng Rev.	*Doshisha Engineering Review.* The Doshisha Kogaku-kai [The Engineering Association], Doshisha University, Karasuma Imadegawa, Kyoto. Vol. 1, No. 1 dated September, 1950.
J. Madras Inst. Technol.	*Journal of the Madras Institute of Technology.* Chromepet, Madras State, India. Published twice annually. Vol. 1, No. 1 dated August, 1952. Annual subscription (Inland), Rs. 8; (Foreign) 16 shillings or 2 dollars.

Errata

p. 5 (1953) [List of Journals] lines 35 and 48: for *Electric Journal* read *Electrical Journal.*

Abstr. 5830 (1952) line 3: *for* V. M. KALMAN *read* V. M. KELMAN.

Abstr. 1864 (1953) line 7: *for* made *read* mode.

Abstr. 2537 (1953) line 4: *for* 318 *read* 518.

Corrections to Articles

Corrections have been published, as shown below, to the articles whose abstract numbers are given. Unless otherwise stated, the volume and page given refer to the journal named in the abstract, i.e. the journal in which the original article was published.

Abstr. 4587 (1951): **21,** 761 (*April,* 1953).

Abstr. 1555 (1952): **18,** 269 (*Jan.,* 1953).

Abstr. 1545 (1953): **21,** 761 (*April,* 1953).

Abstr. 1598 (1953): **21,** 762 (*April,* 1953).

512.3

3781. On the zeros of polynomials and the degree of stability of linear systems. J. F. KOENIG. *J. appl. Phys.*, **24**, 476–82 (*April*, 1953).

A method is presented for finding the zeros of any nth degree real or complex polynomial as its coefficients (or their parameters) are varied. Several new theorems are presented. The method is based on new theorems, some concerning determinants, and on known theorems. It is applied to characteristic equations of linear physical systems with or without feedback. Root trajectories in the complex plane can be visualized without plotting them from "root trajectory diagrams" which show curve families for real or complex roots of a polynomial equation in a plane having two coefficients of the polynomial equation as co-ordinates. The diagrams can be used in the converse manner to determine the coefficient values corresponding to a desired dominant complex pair or real root. A.

517.512.2

3782. Summation of Fourier series. J. A. MCFADDEN. Letter in *J. appl. Phys.*, **24**, 364 (*March*, 1953).

Two methods of summation are presented and compared with three other methods recently described [Abstr. 3683, 8422 (1950), 6982 (1952)]. It is concluded that in a given problem one of these two methods should be tried first, because of its simplicity and wide applicability. L. S. GODDARD

517.512.2 : 537.533.74 : 537.534.74

3783. Calculation of peaked angular distributions from Legendre polynomial expansions and an application to the multiple scattering of charged particles. L. V. SPENCER. *Phys. Rev.*, **90**, 146–50 (*April* 1, 1953).

A method for evaluating Fourier integrals is presented which relies upon qualitative information about the integral and which combines some of the advantages of both numerical and analytic techniques. A formula is then derived which sums slowly convergent series of Legendre polynomials by making use of a Fourier integral "small angle" approximation. A combination of the two techniques is used to sum the slowly convergent Legendre polynomial series which represents the directional distribution of multiply scattered charged particles. Comparisons with "small angle" calculations by Molière and Snyder–Scott are included. A.

517.544 : 512.3

3784. Use of Tschebyscheff-polynomial operators in the numerical solution of boundary-value problems. G. SHORTLEY. *J. appl. Phys.*, **24**, 392–6 (*April*, 1953).

Concerns the numerical solution, in two or more dimensions, of boundary-value problems arising from linear partial differential equations, of which Laplace's and Poisson's equations furnish simple examples. Only techniques suitable for automatic computing machines are considered. The only method previously applicable to automatic machines is a straightforward iteration of an appropriate difference operator applied to an assumed trial solution on a network of points; as has been repeatedly pointed out, the rate of convergence of this iterative procedure is inordinately slow when the number of net points is large. The present paper shows how the employment of a Chebyshev polynomial of this same difference operator can cut the amount of work required in obtaining a solution by a very large factor—a factor of the order of magnitude of $\sqrt{N}$ in the two-dimensional case, $\sqrt[3]{N}$ in the three-dimensional case, where N is the number of net points. This method is an outgrowth of that developed by Flanders and Shortley [Abstr. 780 (1951)] for employment of such Chebyshev-polynomial operators in the numerical solution of eigenvalue problems. The method is illustrated by a simple example involving Poisson's equation. A.

518.2

3785. Tables of Chebyshev polynomials $S_n(x)$ and $C_n(x)$. *Appl. Math. Ser. Nat. Bur. Stand., No.* 9, 161 *pp.* (1952).

Complete tables are given of $C_n(x) = 2T_n(\frac{1}{2}x) = 2\cos(n \arccos \frac{1}{2}x)$ and $S_{n-1}(x) = U_{n-1}(\frac{1}{2}x) = 2\sin(n \arccos \frac{1}{2}x)/(4 - x^2)^{\frac{1}{2}}$ for orders 2(1)12 with $x = 0(0{\cdot}001)2$. Explicit expansions of these functions in powers of x are also given and expansions of the first 12 powers of x in terms of both $T_n(x)$ and $T_n^*(x) = T_n(2x - 1)$. A useful introduction and a preface describe the properties and uses of these polynomials. G. J. KYNCH

518.2

3786. Tables of the Bessel functions $Y_0(x)$, $Y_1(x)$, $K_0(x)$, $K_1(x)$. *Appl. Math. Ser. Nat. Bur. Stand., No.* 25, 60 *pp.* (1952).

These tables for small arguments are a supplement to the B.A. Tables (Vol. VI) of the same functions. Values given are those of $Y_0(x)$ and $Y_1(x)$ to 8 significant figures for $x = 0(0{\cdot}0001)0{\cdot}05(0{\cdot}001)1$ and $K_0(x)$ and $K_1(x)$ to 7 significant figures for $x = 0(0{\cdot}0001)0{\cdot}033(0{\cdot}001)1$. To facilitate interpolation, first and second differences are given for $x > 0{\cdot}005$ and auxiliary functions for use when $x < 0{\cdot}005$, as in the B.A. Tables. G. J. KYNCH

518.2

3787. Addendum to a guide to tables on punched cards. G. BLANCH AND E. C. YOWELL. *Math. Tables Aids Comput.*, **7**, 1–6 (*Jan.*, 1953).

See Abstr. 6985 (1952). A further 30 tables are here listed.

518.3 : 621.3.012.3

3788. A nomogram for functions of more than three variables. O. KLIPPHAHN. *Funk u. Ton.*, **6**, 632–41 (*Dec.*, 1952) *In German.*

Nomograms are given for calculations involving several important quantities, like resistance, inductance and attenuation. Some of these are based on linear laws, such as $z = x + y$, others on power laws, like $z = x^a y^b$. An interesting case is the nomogram giving the effective resistance of a parallel circuit consisting of 3 resistances. Nomograms are also given for the functions $f = 1/2\pi\sqrt{(LC)}$ and $R = 1/2\pi Cdf$.

L. S. GODDARD (R)

518.5

3789. High speed arithmetic: the digital computer as a research tool. H. R. J. GROSCH. *J. Opt. Soc. Amer.*, **43**, 306–10 (*April*, 1953).

The evolution of large electronic computers has been so rapid that the importance of these machines for the optical sciences is not widely recognized. Calculations have already been made with such equipment in the fields of lens design, colour and spectroscopy. Enormous speeds, up to a hundred thousand times that of a desk calculator, and flexible logic of recent general-purpose computers now make possible numerical solution of partial differential equations, synthesis of simple lens systems, correlation of complex infrared spectra with known data, mechanized literature searching and real-time control instrumentation. The limitations imposed by economic considerations, by shortage of trained programming personnel, and by machine breakdown are discussed. A.

518.5 : 621.317.733 : 621.317.79

3790. An analogue computer employing the principle of the Kelvin bridge. V. I. LITTLE. *Proc. Phys. Soc. [London] B*, **66**, 185–8 (*March*, 1953).

A computer is described which permits the rapid evaluation of α from the equation $\cosh 2\alpha S_1/\cosh 2\alpha S_2 = A$, where S_1, S_2 and A are known constants. An accuracy of within $\pm 0{\cdot}2\%$ may be achieved over the working range of the design. A.

518.5 : 621.317.79

3791. A high speed product integrator. A. B. MACNEE. *Rev. sci. Instrum.*, **24**, 207–11 (*March*, 1953).

A method of employing the components of a high-speed analogue computer to evaluate product integrals is presented. Kernel functions of two variables are obtained with time as the variable of integration and the position of ganged potentiometers as the parametric variable. High speed multipliers, function generators, adders and integrators permit the evaluation of a one hundred point product integral curve every 1·67 sec. This curve is displayed on a cathode-ray tube screen having a long persistence P-7 phosphor. Examples of sine and cosine transforms evaluated with the product integrator are given. The observed errors range from 1 to 10%, depending upon the problem. A.

518.5 : 621.317.79 : 621.317.757

3792. A Fourier analyzer. F. J. MCDONAL. *Rev. sci. Instrum.*, **24**, 272–6 (*April*, 1953).

An analogue computer which provides Fourier analyses of transients encountered in seismic research is described. The integral $\int F(t) \sin \omega t dt$ is evaluated by analogue computer elements which perform the generation of the functions $F(t)$ and $\sin \omega t$, multiply the two functions, and integrate the product. The function $F(t)$ is generated from a variable area recording on film by a photocell and amplifier system simultaneously with the generation of the sine function, $\sin \omega t$, by mechanical means. Multiplication of these two functions is performed by the potentiometer method, and integration is accomplished by servo integrators. The instrument also includes control and calibration equipment which facilitates rapid and accurate analyses. A.

519.2 : 621.395.36

3793. On the accuracy of measurements of probabilities of delay and of expected times of delay in telecommunication systems. II. Estimates of average times of delay. L. KOSTEN. *Appl. Sci. Res. B*, **2**, *No.* 6, 401–15 (1952).

For Pt I, see Abstr. 4039 (1951). The expectation of waiting time in delayed call systems can be estimated from the average number of waiting calls during a certain time interval (method C). Another possibility of obtaining the estimate is offered by averaging this number over all moments at which new calls appear. The latter estimate may be performed in two ways (methods A and B). The accuracies of the three estimates are computed and compared. A.

519.25 : 537.3 : 621.396.622

3794. Statistical criteria for the detection of pulsed carriers in noise. I–II. D. MIDDLETON. *J. appl. Phys.*, **24**, 371–8, 379–91 (*April*, 1953).

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521.03

3795. Astrophysics: a topical symposium. Edited by J. A. HYNEK. *New York: McGraw-Hill* (1952) 703 *pp.* + *diagrams.*

Review in *Observatory*, **72**, 244–6 (*Dec.*, 1952).

522.615

3796. Photoelectric transit instrument. T. DAMBARA. *Publ. Astron. Soc. Japan*, **3**, *No.* 1, 37–41 (1951).

To eliminate the personal error a photoelectric-registering apparatus was designed and attached to a Bamberg transit instrument. A special grating with twenty-two slits was used in the focal plane of the telescope instead of the system of wires of the usual registering micrometer. Using a bridge-type balancing circuit, the photoelectric current was amplified up to operate an ink-writing oscillograph. Preliminary observations show promising results. A.

523.11

3797. On Hoyle's continuous creation theory. H. NARIAI. *Publ. Astron. Soc. Japan*, **3**, *No.* 3–4, 139–43 (1952).

Starting from the stationarity postulate to the smoothed-out expanding universe with negligible pressure and from the normalization condition of the creation tensor, without recourse to the creation vector, the authors obtained new gravitational field equations together with an alternative quantitative definition of the creation tensor. See also Abstr. 5010 (1951). A.

523.11 : 538.56

Equations of motion from an ideal plasma. *See Abstr.* 4222

523.152.2

3798. The interstellar structures. I. Gas clouds. E. N. PARKER. *Astrophys. J.*, **117**, 169–76 (*Jan.*, 1953).

In an effort to arrive at a dynamical model for the interstellar medium, its mechanical properties are discussed. Using a polytrope relation between the temperature and density within a gas cloud, the mechanical and then the statistical properties of an idealized model of the interstellar clouds are developed. One finds that the collision rate of clouds, computed in an elementary fashion from their diameters and random translational velocities, leads to several difficulties. First, the very inelastic nature of head-on collisions would rapidly reduce the translational velocities, and it would be difficult to explain the observed radial velocities. Second, there would be a strong tendency toward statistical equilibrium of the internal state of the clouds. The equlibrium is investigated, and the cloud is found to be either in a collapsed condition or completely dispersed, again contrary to observation. Ordering of the translational velocities is proposed as one means of circumventing these difficulties. In any case, the tendency of clouds to collapse, possibly to form clusters of stars, is shown to be intrinsic in their nature. A.

523.152.2 : 523.75 : 538.56

3799. Magneto-hydrodynamic shock waves. H. L. HELFER. *Astrophys. J.*, **117**, 177–99 (*Jan.*, 1953).

An interpretation of the de Hoffman–Teller shock-wave equations for an infinitely conducting medium is given analogous to the classical interpretation of the ordinary hydrodynamic shock-wave equations of Rankine and Hugoniot. Two cases of interest are considered as a consequence of this theory. It is shown that weak magnetic fields in interstellar clouds will be amplified, and, if external mechanisms are available to reduce the compressional effects of shock waves, the field will reach a value $H \sim (8\pi p)^{1/2}$, where p is the pressure. Also, some aspects of the internal motions of prominences are considered; it is shown that $H \sim 0{\cdot}1$ gauss will yield results in accord with the observational material. A.

523.34

3800. The surface temperature of the moon. J. C. JAEGER. *Austral. J. Phys.*, **6**, 10–21 (*March*, 1953).

Results of numerical calculations are given for (i) the fall in surface temperature during a lunar eclipse, (ii) the variation in surface temperature at the equator during a lunation, and (iii) the variation in microwave temperature at the equator during a lunation. These calculations are made on the assumption that heat is lost from the surface by radiation according to the fourth power law. Two models are considered, firstly, that in which the surface material of the moon is homogeneous, and secondly, that in which it consists of a thin skin of poor conductor on a better conducting substratum. The experimental results are discussed in the light of these calculations and it is found that none of the proposed models fits them all adequately, and, though there is a slight preference for the thin skin model over the homogeneous solid, it is not possible to discriminate between the two on the information at present available. See also Abstr. 1579 (1951). A.

523.5

3801. Bibliography on meteoritic dust with brief abstracts (including compilation by the late Willard J. Fisher). D. HOFFLEIT. *Harvard Coll. Obs. tech. Rep.*, *No.* 9, 45 *pp.* (1952).

523.51 : 537.591

Meteorites as cosmic ray meters. *See Abstr.* 4182

523.53 : 621.396.969

3802. An experimental study of radio reflections from meteor trails. R. L. CLOSS, J. A. CLEGG AND T. R. KAISER. *Phil. Mag.*, **44**, 313–24 (*March*, 1953).

The character of the radio echoes obtained from the ionized trails produced by meteors has been investigated. The dependence on the polarization of the incident wave has been studied and the existence of resonant scattering with transverse polarization verified. The magnitude of the resonance and its dependence on the electron line density, α, is found to be in good agreement with theory, as is also the variation of echo amplitude with α. A.

523.72

3803. The solar noise from the coronal prominences. S. MIYAMOTO. Note in *Publ. Astron. Soc. Japan*, **3**, *No.* 1, 61–5 (1951).

The solar noise from the cooling coronal prominence was examined. A considerable amount of its thermal energy is transformed to radiowaves. The usual atomic emission probability of free-free transition breaks down for radiowave emission for the coronal and chromospheric density. A preliminary modification suggests a very strong dependence of the emission probability upon the wavelength and ion density. Some characteristics of the noise were considered with the modified formula. A.

523.72

3804. Mapping the magnetic fields of the sun. H. W. BABCOCK AND H. D. BABCOCK. *Publ. Astron. Soc. Pacific*, **64**, 282–7 (*Dec.*, 1952).

An apparatus for measuring the magnetic field of a localized region of the solar surface, with a device for scanning the solar disk in about 50 min, is described. The field is measured by means of a photoelectric detector having two slits symmetrically disposed in the wings of the chosen line whose longitudinal Zeeman effect is to be measured, with two photomultipliers connected to a difference amplifier. The circular analyser used consists of an ammonium-dihydrogen-phosphate plate to which a 120-cycle alternating voltage can be applied, followed by a Nicol prism. Preliminary results show that magnetic fields ~30 gauss may persist over large areas where no spots are observed, although such fields show a tendency to persist after a spot has disappeared or in a region where a spot subsequently appears. Sunspot groups show, in addition to their strong fields, smaller fields ~10 gauss up to distances of several minutes of arc. Smaller persistent fields are observed at high latitudes, there being slight evidence for a weak distorted dipole general field for the sun with sign opposite to that of the earth.

M. W. OVENDEN

523.72

3805. An estimate of the density and motion of solar material from observed characteristics of solar radio outbursts. H. K. SEN. *Austral. J. Phys.*, **6**, 67–72 (*March*, 1953).

The theory of radiowave generation by multistream charge interaction [Abstr. 7112 (1951)] is extended and applied to the observations made by Australian workers [Abstr. 2329 (1950)] of the spectrum of outbursts of solar radio-frequency radiation in the frequency range 70–130 Mc/s. The dispersion equation is derived as a function of the velocity of solar material erupting into a static corona and of the temperatures and densities of the material and the corona. The application of the dispersion equation to the Australian data enables an estimate to be made of the velocity ($\simeq$500 km/s) and the particle density ($\simeq 10^8$ cm^{-3}) of the moving solar material. A.

523.72

3806. On the sun's interior. I. EPSTEIN AND L. MOTZ. *Astrophys. J.*, **117**, 311–12 (*March*, 1953).

A revised model interior for the sun is calculated, with an improved value for the rate of energy generation through the proton-proton reaction. It is found that the observed values of the radius, mass and luminosity may be obtained if one squeezes the helium content to zero. The composition parameters for this equilibrium model are $X = 99{\cdot}8\%$, $Z = 0{\cdot}2\%$. The central temperature of this model is 12 000 000°, while its density is 110. The upper limit for a possible convective core is 8% of the radius. Such a core could not include more than 3% of the mass, nor could more than 24% of the total energy be generated there. The proton-proton reaction provides all the energy generation in this model. A.

523.72

3807. A method of analysis of the directivity of solar radio emission from sunspots. T. TAKAKURA. Letter in *Nature* [*London*] **171**, 445 (*March* 7, 1953).

The directivity is examined by finding for various radio wavelengths the value of n for which the correlation of sunspot radio emission with $nA_1 + A_2$ is greatest, where A_1 is the Wolf number for a central circular zone of radius one-half the radius of the sun, and A_2 the Wolf number for the remainder of the solar disk. M. W. OVENDEN

523.72 : 537.591.5

World-wide effects of continuous emission of cosmic rays from the sun. *See Abstr.* 4192

523.741

3808. Preliminary analysis of the turbulence spectrum of the solar photosphere at long wave lengths. F. N. FRENKIEL AND M. SCHWARZSCHILD. *Astrophys. J.*, **116**, 422–7 (*Sept.*, 1952).

The available data on the velocities of granules are analysed according to the methods of the statistical theory of turbulence. The analysis indicates that the turbulence spectrum of the solar photosphere may not be of a simple form but may have—in addition to the suspected primary maximum at wavelengths of the order of 300 km—a secondary maximum at long wavelengths of about 15 000 km. A.

523.75 : 523.72

3809. Ejection of hydrogen and ionized calcium atoms with high velocity at the time of solar flares. H. W. DODSON, E. R. HEDEMAN AND J. CHAMBERLAIN. *Astrophys. J.*, **117**, 66–72 (*Jan.*, 1953).

High-velocity ejections of both hydrogen and ionized calcium atoms at the time of onset of five flares near the solar limb are described. For four of the five cases, reports of solar radiation at radio frequencies are available and indicate bursts or "outbursts" at the start of the flare and ejection. Consideration of time relationships and of the frequency of occurrence of 200 Mc/s bursts with flares leads to the suggestion that the burst at radio frequencies is to be associated with the high-velocity ejection rather than with the Hα brightening. A.

523.752

3810. On the anomalous excitation of the chromospheric hydrogen spectrum. S. MIYAMOTO. *Publ. Astron. Soc. Japan*, **3**, *No.* 1, 16–23 (1951).

The anomalous excitation of the chromospheric hydrogen spectrum was attributed to the effect of proton inflow from the hot corona by turbulence, and subsequent recombination. When the kinetic temperature of the chromosphere is as low as the photospheric one, the degree of ionization is small, and the chromosphere shows large opacity for the Lyman continuous radiation. Under these circumstances, a small amount of proton inflow is sufficient to produce considerable internal field and to account for the observed anomalous excitation of the Balmer emission. A.

523.752

3811. On the population of the hydrogen atoms in the second state in the solar chromosphere. I. KAWAGUCHI. *Publ. Astron. Soc. Japan*, **3**, *No.* 3–4 171–7 (1952).

Analytic expressions for the integrated emission curve of growth for the Balmer higher members were derived. From this the population of hydrogen 2nd state was estimated using the observation made by Cillié and Menzel (1935). The result is that the numbers of second level atoms contained in the tangential column through the chromospheric base is about 10^{16} cm^{-2}, in the case of the electron temperature 6000° or 35 000°. It is in good agreement with the result obtained by Thomas (1950), who calculated it for the case of cascade transition. But the present calculation shows that the main contribution is due to scattering. A.

523.77

3812. The solar spectrum from 7 μ to 13 μ. J. H. SHAW, M. L. OXHOLM AND H. H. CLAASSEN. *Astrophys. J.*, **116**, 554–74 (*Nov.*, 1952).

The infrared solar spectrum from 7 μ to 13 μ has been reinvestigated at the Ohio State University with a high-resolution grating spectrometer. A map of the spectrum is presented, together with a table of line frequencies, and line identifications are given where possible. Absorption bands of atmospheric H_2O, CO_2, O_3, N_2O and CH_4 are described, and the existence of other possible atmospheric constituents is discussed briefly. A.

523.77

3813. The solar spectrum from λ2285 to λ3000 Å. H. E. CLEARMAN. *Astrophys. J.*, **117**, 29–40 (*Jan.*, 1953).

Presents measurements on the solar spectra previously obtained by Hopfield and Clearman. A complete wavelength list is given, together with a discussion of the element identifications. An intensity-curve is given covering the region λλ2575–2900 Å. Equivalent widths of several strong lines are estimated. A value of the Mg/Ca abundance ratio is calculated from a discussion of the emission lines in the centre of the Mg II and Ca II resonance lines. A.

523.77

3814. Table of infrared solar lines, 1·4–2·5 μ. O. C. MOHLER, A. K. PIERCE, R. R. MCMATH AND L. GOLDBERG. *Astrophys. J.*, **117**, 41–65 (*Jan.*, 1953).

Accurate wavelengths and measurements of equivalent width are given for 888 solar lines in the spectral region 1·4–2·5 μ. The number of solar lines has been more than doubled, as compared with previous preliminary studies in this spectral region. The wavelengths of the solar lines are referred to those of the Fraunhofer lines in the visible and very near infrared spectrum by the method of overlapping orders. The root-mean-square errors of the infrared standard wavelengths, as derived from repeated measurements of individual lines, are ±0·13 Å for the 1·6 μ region and ±0·17 Å for the 2·3 μ region. The equivalent widths are preliminary. The estimated errors are between 10 and 100%, depending upon the degree of blending. About 470 infrared solar lines have been tentatively identified with atoms of H, K, C, Al, Na, Si, Mg, Ca, Ni and Fe and with first overtone lines of CO. Comparisons between solar wavelengths and those measured in the laboratory or predicted from term values reveal somewhat closer agreement, on the average, between the solar and the predicted values than between the solar and the laboratory values. A.

523.77

3815. Rocket spectroscopy. R. TOUSEY. *J. Opt. Soc. Amer.*, **43**, 245–51 (*April*, 1953).

The results of studies of the solar spectrum made from rockets and extending from the u.v. to soft X-rays are reviewed. Experiments with spectrographs have given the solar intensity distribution to 2000 Å, the Fraunhofer spectrum to 2300 Å with varying resolution reaching 0·6 Å above 2630 Å, and the magnesium doublet at 2800 Å with intense emission cores. The vertical distribution of ozone was determined to 70 km and found to be in agreement with a photochemical calculation. Diurnal heating in the ozone layer was calculated. The intensity of Lyman alpha of hydrogen, 1216 Å, was measured with photon counters and with a thermoluminescent phosphor, and solar X-rays from 5–7 Å were observed by these methods and also by direct photography through filters. The absorption of X-rays was found to occur in the *E*-layer and must account, at least in part, for its production. A.

523.775

3816. The lifetime of the $2^2S_{1/2}$ state of hydrogen in an ionized atmosphere. E. M. PURCELL. *Astrophys. J.*, **116**, 457–62 (*Nov.*, 1952).

The probability of the transitions $2^2S_{1/2} \rightarrow 2^2P_{1/2}$ and $2^2S_{1/2} \rightarrow 2^2P_{3/2}$ resulting from collisions of hydrogen atoms in $2^2S_{1/2}$ state with electrons and positive ions is calculated. The dominant effect of the protons is shown. The population of the 2*S* state under chromospheric conditions is found to be substantially lower than the estimates of Giovanelli, and the appearance of the line $2^2S_{1/2} \rightarrow 2^2P_{3/2}$ in absorption is improbable. A.

523.775

3817. Emission of radiation from model hydrogen chromospheres. J. T. JEFFERIES. *Austral. J. Phys.*, **6**, 22–44 (*March*, 1953).

On the basis of earlier work of Giovanelli (1949), the characteristics of the radiation fields of Hα, Lα, Lβ and the Lyman continuum have been calculated for model solar atmospheres consisting of a photosphere and an overlying chromosphere which scatters coherently, and which is isothermal at one of a number of kinetic temperatures in the range 1×10^4 to $2\cdot5\times10^5$ °K. The computed central intensities (of Hα) suggest that the kinetic temperature of those regions responsible for the observed solar Hα radiation lies somewhere in the range up to about $3\cdot5\times10^4$ °K. The best agreement with observation, for those temperatures considered, is obtained for $2\cdot5\times10^4$ °K, with an electron concentration 2×10^{11} per cm³ at the base of the chromosphere. Too much reliance should not be placed on this result, for the obvious non-uniformity of the solar chromosphere and its effect on the hydrogen lines has not been taken into account. The effective black-body temperature for the centres of the Lα and Lβ lines and for the Lyman series limit have been calculated; the results indicate that the intensities in each case pass through a maximum at a kinetic temperature about 5×10^4 °K. The half-widths of Lα and Lβ show a steady decrease with increasing temperature up to 5×10^4 °K; for higher temperatures the half-width increases. The contours of Lα and Hα have also been computed on the basis of a simple model of non-coherent scattering in which the absorbed radiation is redistributed over a Doppler profile; the results indicate that the type of scattering is unimportant for Hα, but may considerably modify the profiles of the Lyman lines. A.

523.841.11 : 523.877

3818. On the neutrino energy of a supernova. P. BOUVIER. *Arch. Sci.* [*Geneva*] **5**, *No.* 4, 221–8 (1952) *In French.*

Under suitable conditions an appreciable neutron concentration may exist in stellar material. An estimate is therefore made of the rate of absorption of neutrinos by neutrons and is found to be negligibly small. The transparency with regard to neutrino flux required by the Gamow–Schoenberg theory is not affected by the presence of neutrons. R. A. NEWING

523.852.22

3819. On the radiation pressure in a planetary nebula. II. W. UNNO. *Publ. Astron. Soc. Japan*, **3**, *No.* 3–4, 158–70 (1952).

For Pt I, see Abstr. 4057 (1951). The intensity and the radiation pressure of Lyman alpha line radiation in a planetary nebula are discussed in detail. The equation of transfer for this radiation is deduced in exact form, taking into account the redistribution in frequency in the line contour. A

mean value solution is obtained within each frequency range of $2/\sqrt{\pi}$ times Doppler width. The solution for the complete redistribution approximation is calculated in the same way. The results are not very different in most cases, but at the outer boundary the radiation pressure calculated from the complete redistribution approximation is about twice as great as that from the exact solution. It is also found out that Zanstra's rough estimate gives the correct order of magnitude for this problem throughout the nebula except at the extreme outer boundary. A.

523.852.22

3820. On the radiation pressure in a planetary nebula. III. Problem of He II. W. Unno. *Publ. Astron. Soc. Japan*, **3**, *No.* 3–4, 178–83 (1952).

The radiation pressure due to the L_α radiation of He II is calculated. The effect of the Bowen mechanism as well as the Zanstra effect is taken into account in the calculation. The former may weaken the resonance character of this line by nearly the same amount as the latter in the ordinary planetary nebula condition. The amount of the reduction of the He II L_α radiation pressure may be enough to make the nebula safe from explosion caused by this radiation. A.

523.852.22

3821. On the internal motions in planetary nebulae. W. Unno and K. Takakubo. *Publ. Astron. Soc. Japan*, **3**, *No.* 3–4, 195–208 (1952).

The internal motions and the stratifications of ions in high-excitation planetary nebulae are discussed and calculated for several models. The radiation pressure for He II plays the principal role in the internal motions of nebulae. Explanations of Wilson's observations (1950) of the separations of the components of the double nebular lines and of the corresponding monochromatic images are given. A.

523.854

3822. Problems of galactic structure. J. H. Oort. *Astrophys. J.*, **116**, 233–50 (*Sept.*, 1952).

523.854.1

3823. Fluctuations in brightness of the Milky Way. D. N. Limber. *Astrophys. J.*, **117**, 145–68 (*Jan.*, 1953).

The recent Chandrasekhar–Münch theory of fluctuations in the brightness of the Milky Way in terms of a fluctuating field of absorbing matter is extended to systems of finite extent. The theoretical extensions necessary for the analysis of observational material are developed, and the analysis of Pannekoek's isophotal charts of the Southern Milky Way is carried out. The latitude dependence of the brightness correlations given by the theory is found to give satisfactory agreement with the observations for: (1) a microscale of the fluctuations of 0·01 in units of the mean optical thickness; (2) a root mean square of the fluctuations in the density of $5\bar{\rho}$; and an "effective" half-thickness of the relevant galactic absorbing matter of $0^m.20$. A.

523.854.1 : 523.165

3824. Spiral structure and interstellar radio emission. J. F. H. Oort and C. A. Muller. *S. African J. Sci.*, **49**, 87–92 (*Oct.–Nov.*, 1952).

A summary of the observations of fine-structure of the 21·1 cm line emitted by H I regions, which lead to the delineation of galactic spiral arms.

M. W. OVENDEN

523.855

3825. On the spatial distribution of galaxies. A specific model. J. Neyman, E. L. Scott and C. D. Shane. *Astrophys. J.* **117**, 92–133 (*Jan.*, 1953).

Counts of galaxies in $1° \times 1°$ squares obtained at the Lick Observatory are used to test whether the serial correlations between these counts are compatible with the hypotheses that (i) galaxies occur only in clusters; (ii) the spatial distribution of cluster centres is quasi-uniform and, to be specific, follows a Poisson law; (iii) the number ν of galaxies per cluster is a variable following an unspecified probability law with mean ν_1 and standard deviation σ_ν; (iv) the distribution of position of galaxies within a cluster follows a symmetric normal distribution with standard deviation σ. The outcome of the test is favourable to the hypotheses enumerated. It is noted that the parameter σ measures, in a sense, the dimensions of the cluster. In order to obtain the most probable distance of the galaxy farthest from the cluster centre, σ should be multiplied by a factor usually between 3 and 4, depending on the number of galaxies in the cluster. Numerical results include estimates of σ varying from 3×10^5 to 14×10^5 parsecs, according to the assumptions concerning the distribution of absolute magnitudes of the galaxies with $\sigma = 3{\cdot}7 \times 10^5$ parsecs as the tentative best-fitting estimate. Further numerical results, combined with certain plausible hypotheses, imply that ν_1, the average number of galaxies per cluster, is less than 287; that the standard deviation σ_ν of the number of galaxies per cluster is less than 144 and more than (probably much more than) 17; and that λ, the average number of cluster centres per cubic parsec, is between $0{\cdot}12 \times 10^{-18}$ and 34×10^{-18}. Tentative computations based on the assumption that $\nu - 1$ follows a negative binomial distribution show that the theory is compatible with the fact that within the area studied there are identified a number of very small clusters and, at the same time, a few giant clusters. The best agreement between the theoretical and empirical serial quasi-correlations is obtained on the assumption that the standard deviation of the absolute magnitude of galaxies is $\sigma_M = 1{\cdot}25$ mag. A.

523.877

3826. On the radiation field of the extended stellar atmospheres. J. Jugaku. *Publ. Astron. Soc. Japan*, **3**, *No.* 1, 42–8 (1951).

See Abstr. 3298 (1951). Following the formulation given by Miyamoto, the radiation field of the extended stellar atmospheres has been treated, taking Zanstra's effect and the effect of fluorescence into account. For three cases of the dilution factor, i.e. $W = 0{\cdot}01$, $0{\cdot}001$ and $0{\cdot}0001$, the numerical computations of the field of Lyman alpha radiation are given. The Lyman alpha flux, and consequently the Lyman alpha pressure, is less than that of the ultraviolet for the greater part of the atmosphere, but at the outermost part, the pressure becomes much stronger. This result is in agreement with that obtained by Miyamoto. A.

523.877

3827. On the equilibrium of a thin atmosphere round a heavy central core: spheroidal and anchor-ring configurations. N. L. GHOSH. *Bull. Calcutta Math. Soc.*, **44**, 22–6 (*March*, 1952).

It is assumed that the gravitational field at any point is wholly due to a heavy spherical body at the centre. It is found that it is possible for a thin rotating atmosphere to exist in the form of an oblate spheroid surrounding the spherical core, or in the form of an anchor-ring belt of elliptic cross-section rotating with a variable angular velocity. Under certain restrictions the density diminishes outwards steadily.

L. S. GODDARD

523.877

3828. A note on the limiting mass of a rotating white dwarf. G. BANDYOPADHYAY. *Bull. Calcutta Math. Soc.*, **44**, 89–91 (*June*, 1952).

It is shown that Chandrasekhar's limiting value (1938) for the mass of a static white-dwarf star holds also for a rotating star, at least up to angular velocities $10^3 \times$ that of earth. The result apparently contradicts that obtained by Hoyle (1947) who found no limiting mass in the special case involving a differential rotation of the stellar material. D. R. BARBER

523.877

3829. Magneto-hydrodynamic oscillations of a star. G. GJELLESTAD. *Ann. Astrophys.*, **15**, 276–89 (*July–Sept.*, 1952).

A mathematical treatment of Schwarzschild's problem postulating an incompressible, homogeneous star in empty space. If the current system induced by the pulsating magnetic field is concentrated at the stellar surface, it is possible to obtain solutions of the problem in which the internal motions are the same as when no inducing field is present. D. R. BARBER

523.877

3830. Some formulae for the emergent intensities by the Laplace transformation. S.-S. HUANG. *Ann. Astrophys.*, **15**, 352–8 (*July–Sept.*, 1952).

It is shown that Chandrasekhar's solution for radiation intensities emergent from certain stellar atmospheres may be obtained (for the Milne–Eddington model) directly from Schwarzschild's equation, and for diffuse reflection from the source-function equation, by means of the Laplace transformation.

D. R. BARBER

523.877

3831. On the decay of a primeval stellar magnetic field. M. H. WRUBEL. *Astrophys. J.*, **116**, 291–8 (*Sept.*, 1952).

The shapes and decay times of three possible stellar magnetic fields were calculated by using a radial distribution of conductivity derived from Schwarzschild's temperature distribution. These particular fields would be expected to have the greatest longevity. Their decay times were found to be in the ratio $1{\cdot}00 : 0{\cdot}40 : 0{\cdot}24$; in the case of the sun, the fundamental field would decay to $1/e$ of its initial value in $4{\cdot}08 \times 10^9$ years. More massive stars would be expected to have fields with lifetimes longer by a factor proportional to $R^2T_c^{3/2}$. The effect of a different temperature distribution on these results is also discussed. A.

523.877

3832. Inhomogeneous stellar models. I. Models with a convective core and a discontinuity in the chemical composition. J. B. OKE AND M. SCHWARZSCHILD. *Astrophys. J.*, **116**, 317–30 (*Sept.*, 1952).

A number of stellar models with a discontinuity in chemical composition have been computed through in detail. An arbitrary, but fixed, hydrogen-poor composition was used for the interior of all models, and a fixed hydrogen-rich composition was similarly used for all envelopes. The position in the star at which the change in chemical composition occurs was varied over a wide range. The computed models were found to cover well the observed red giants, as far as radii and luminosities are concerned. The masses of the theoretical red-giant models, however, fall systematically somewhat below the standard mass-luminosity relation—a circumstance not necessarily in discordance with observation. A.

523.877

3833. Inhomogeneous stellar models. II. Models with exhausted cores in gravitational contraction. A. R. SANDAGE AND M. SCHWARZSCHILD. *Astrophys. J.*, **116**, 463–76 (*Nov.*, 1952).

Seven shell-source models with exhausted, gravitationally contracting cores have been computed in detail. The models form an evolutionary sequence starting from a configuration whose isothermal core contains the Schönberg–Chandrasekhar limiting mass. It is found that, as the cores contract, the envelopes greatly expand. Thus from the initial configuration, which is near the main sequence, the stars evolve rapidly to the right in the H-R diagram, amply covering the giant region. In this evolution the gravitational contraction contributes less than 4% to the total luminosity. A comparison of this theoretical evolution with the observed H-R diagram for globular clusters appears to explain the sudden turnoff from the main sequence to the giant region at about $M_{bol} = +3{\cdot}5$. A.

523.877

3834. The curve of line-width correlation and Doppler velocities in stellar atmospheres. I. Delta Canis Majoris. S.-S. HUANG AND O. STRUVE. *Astrophys. J.*, **116**, 410–21 (*Sept.*, 1952).

A new method of studying Doppler velocities in stellar atmospheres is proposed. It depends upon a relation between the equivalent widths and the half-widths of the absorption lines. Turbulent velocities of both large and small eddies can be determined by this method. Applying it to δ Canis Majoris the turbulent velocities of large eddies are found to be practically constant with respect to the strengths of the absorption lines and the turbulent velocities of small eddies are found to increase very rapidly with the increase of line intensities. A general discussion is given of the interrelationship between the turbulent spectrum and the Doppler broadening of absorption lines, but no attempt has been made to explain the physical nature of the large eddies. A.

523.877

3835. The internal temperature of white dwarfs. E. SCHATZMAN. *Ann. Astrophys.*, **15**, 361–3 (*Oct.–Dec.*, 1952) *In French.*

Assuming for the white-dwarf stars a constitution

represented by a core of heavy elements surrounded by a H mantle, the internal temperature of the star may be computed by a numerical integration method; mass, luminosity and temperature being related by the empirical formula, $T = 10^{7\cdot567}(L/M)^{0\cdot349}$. Values of T thus found are consistently lower than those computed by a previous method (1950). D. R. BARBER

523.877

3836. A gravitationally contracting stellar model. R. D. LEVEE. *Astrophys. J.*, **117**, 200–10 (*Jan.*, 1953).

A stellar configuration under homologous gravitational contraction is considered. The energy generation is given by $\varepsilon = \varepsilon_0 T$, radiation pressure is neglected, and the opacity is given by Kramers' law. The solution yields three eigenvalues: The central value of the polytropic index, the constant of the mass-luminosity equation and the constant of the equation of energy generation. The distributions of ρ, T, $M(r)$ and $L(r)$ are almost identical with those of the standard model, although ρ_c and T_c are slightly higher, since the polytropic index varies from 2·97 at the centre to 3·25 at the surface. The mass-luminosity equation shows that $L \propto R^{-0\cdot5}$ for constant M and leads to a time scale of 5×10^7 years for the sun. A.

523.877

3837. The variational method for problems of radiative transfer. I. Isotropic scattering with a constant net flux. S.-S. HUANG. *Astrophys. J.*, **117**, 211–14 (*Jan.*, 1953).

The variational method for problems of radiative transfer is further simplified, so that it can be used easily for many problems encountered in astrophysics. In this first paper of the series this new method has been applied to the Milne problem and an approximate solution for the source function found. The approximate solution agrees extremely well with the exact solution at all points where the numerical evaluation for the latter has already been carried out. Unlike the exact solution, the approximate solution has a simple analytical form and is very easy to evaluate numerically at any point. A.

523.877

3838. The variational method for problems of radiative transfer. II. The formation of absorption lines in the Milne–Eddington model. S.-S. HUANG. *Astrophys. J.*, **117**, 215–20 (*Jan.*, 1953).

The variational method has been applied to the problem of the line formation in the M–E model. Making use of the asymptotic form of the source function first obtained by Menzel and Sen, it is possible to derive, with one parameter in the trial function, a simple explicit formula for the profile, with an error of only about 0·2%. A formula derived from a trial function having three parameters is also given. A numerical example shows that it agrees extremely well with the results obtained by the use of other methods. A correct asymptotic form is the main reason for the high accuracy in the final result without introduction of too many parameters in the trial function. A.

523.877

3839. The variational method for problems of radiative transfer. III. Reflection effect. S.-S. HUANG. *Astrophys. J.*, **117**, 221–4 (*Jan.*, 1953).

The variational method has been applied to the problem of diffuse reflection by a plane-parallel atmosphere scattering radiation isotropically. Approximate expressions with five parameters have been derived both for the source function and for the emergent radiation. The numerical results are in good agreement with those computed by other methods. A.

523.877 : 523.854

3840. The transfer of radiation by an emitting atmosphere. H. G. HORAK. *Astrophys. J.*, **116**, 477–90 (*Nov.*, 1952).

The transfer of radiation by a plane-parallel atmosphere containing a uniform distribution of emission sources is considered for two cases: (*a*) isotropic scattering with an albedo ϖ_0, (*b*) scattering according to the asymmetric phase function $\varpi_0(1 + x \cos\theta)$. The exact expressions for the emergent intensity are derived for both semi-infinite and finite atmospheres. It is also shown how the intensity at any optical depth may be obtained. The formulae are applied to the case of the galactic light. A.

525.35

3841. The lengthening of the period of the free nutation due to the inequality of three principal axes of the earth. C. SUGAWA. *Publ. Astron. Soc. Japan*, **3**, *No.* 1, 1–4 (1951).

The lengthenings of the Eulerian and the Chandlerian periods were estimated from recent geodetic observations, for example, Heiskanen's determination (1928) and Helmert's observation (1915). It was found that the lengthening of the Eulerian period is only about 0·5 hr and that of the Chandlerian period is also only about 1 hr. A.

525.35

3842. Effects of the short period oceanic tides on the rotation of the earth. N. SEKIGUCHI. *Publ. Astron. Soc. Japan*, **3**, *No.* 1, 24–36 (1951).

The effect of the terrestrial-rotation velocity of the short-period (<1 day) tidal components generated by action of the sun and moon is obtained by numerical integration of M_2 and S_2 tides over the entire ocean surfaces. Their influence on precession, nutation and polar motion is found negligibly small. A marked effect is found, however, when the secular change of rotation is considered, the computed perturbation being much greater than that observed. D. R. BARBER

PHYSICS 53

53

3843. Introduction to concepts and theories in physical science. G. HOLTON. *Cambridge, Mass.: Addison Wesley Press* (1952) *xviii* + 650 *pp.*

Review in *Proc. Phys. Soc.* [*London*] *A*, **66**, 310–11 (*March*, 1953).

53.081

3844. A proposed procedure for selecting and using symbols for physical units. D. ROLLER. *Amer. J. Phys.*, **21**, 293–6 (*April*, 1953).

Since the symbols—names, or their abbreviations—for physical units may be incorporated in physical

equations in exactly the same manner as are the letter symbols for physical quantities and the numerical symbols, it follows that the rules for selecting and using these unit-symbols should be formulated in the light of established mathematical procedures. A set of such rules is proposed. Symbols are suggested for 185 commonly used units and combining forms. A.

53.081 : 621.3.081

3845. An electro-mechanical system [of units] with MLT dimensions. M. DEHALU. *Bull. Soc. Roy. Sci. Liège*, **21**, 389–402 (*Nov.*, 1952) *In French.*

Recapitulates and discusses the Giorgi system and compares it with Berger's proposal [Abstr. 591 (1953)] in the light of Esnault–Pelterie's analysis.

S. WEINTROUB

53.081.5 : 621.3.081.5

3846. A calculus of measures and its application to the relation between rationalized and unrationalized electromagnetic systems. J. R. BARKER AND R. O. DAVIES. *Amer. J. Phys.*, **21**, 281–6 (*April*, 1953).

When changing units and in dimensional analysis it is usual to employ the relation, physical quantity = measure × unit. Neither the "physical quantity" nor the "unit" is supposed to be a real number and yet the formalism is normally effective. This fact is given a rational explanation and the ideas involved are used to discuss certain questions connected with the rationalization of the electromagnetic equations. A.

FUNDAMENTALS 530.1

530.112

3847. Genesis of the query "Is there an ether?" H. E. IVES. Letter in *J. Opt. Soc. Amer.*, **43**, 217–18 (*March*, 1953).

In an historical survey, it is maintained that the grounds for abolishing the ether were mistaken.

R. A. NEWING

530.12

3848. Conformal relativity. R. L. INGRAHAM. *Proc. Nat. Acad. Sci. U.S.A.*, **38**, 921–5 (*Oct.*, 1952).

A preliminary report on a theory to be developed in a later paper in which the 5-dimensional space-time-gauge continuum is described in terms of hexaspherical co-ordinates. General theory is expressed in terms of a conformal space, subject to a condition of minimum total curvature which provides gravitational, electromagnetic and meson fields. The theory involves a class of preferred systems which can be identified with observers in uniform relative acceleration.

R. A. NEWING

530.12

3849. The boundary conditions in gravitational fields of spherical symmetry. P. C. VAIDYA. *J. Univ. Bombay*, **21**, 1–7 (*Nov.*, 1952).

See Abstr. 18 (1953), 8650 (1952).

530.12 : 523.112

3850. A note on the apparent disappearance of radiation in the theory of the expanding universe. N. MAJUMDAR. *Bull. Calcutta Math. Soc.*, **44**, 86–8 (*June*, 1952).

Tolman's discussion of the flow of radiation into internebular space is amplified by the approx. integration of an equation for radiation density. It is concluded that radiation pressure would cease to increase in a time of order 10^9 years after the beginning of expansion. R. A. NEWING

530.12 : 530.145

3851. A general relativistic approach to short-range forces. H. AMAR. Letter in *Phys. Rev.*, **89**, 1298 (*March* 15, 1953).

A generalization of the field equations is proposed in the form $R_{\mu\nu} = \Lambda^{\sigma}_{\mu} g_{\sigma\nu}$. With a suitable choice of Λ^{σ}_{μ} the new equations possess a solution reducing to Schwarzschild's in the large, and giving gravitational interactions of order 2 MeV in the nuclear, range.

R. A. NEWING

530.145

3852. The principles of quantum mechanics. W. V. HOUSTON. *London: McGraw-Hill* (1951) *viii* + 288 *pp.*

Review in *Proc. Phys. Soc.* [*London*] *A*, **66**, 199 (*Feb.* 8, 1953): "Written principally for graduate students studying modern theoretical physics."

530.145

3853. Commutation relations in Lagrangian quantum mechanics. W. K. BURTON AND B. F. TOUSCHEK. *Phil. Mag.*, **44**, 161–8 (*Feb.*, 1953).

Schwinger's method for deriving commutation relations is shown to fail in the case of first-order equations of motion. A new method, adapted from some recent work of Peierls, is discussed in connection with two examples of first-order equations in point mechanics. A.

530.145

3854. The significance of the quantum of action. J. FUCHS. *Elektrotech. u. Maschinenbau* [*EuM*] **70**, 77–87 (*Feb.* 15, 1953) *In German.*

It is shown that the Planck quantum of action h can be expressed in a physically significant form as a function of the electric and magnetic properties of the elementary charge and of the vacuum in the form $h = \frac{1}{2}e^2 137(\mu_0/\varepsilon_0)^{\frac{1}{2}}$. The substitution of h in various atomic and nuclear equations shows (with precautions relating to the velocity of light c and the classical electron radius r_0) that the quantum of action can be eliminated therefrom, provided that a hitherto unknown constant takes its place. The equations thus derived show heuristically valuable forms of new physical significance. They support the conception that the existence of the quantity h is one of the results of the finite value of the elementary charge and not its cause. A.

530.145

3855. The physical aspects of the wave-particle problem of quantum mechanics. L. JÁNOSSY. *Ann. Phys.* [*Leipzig*] **11**, *No.* 4–7, 323–61 (1953) *In German.*

German version of the paper abstracted in Abstr. 1371 (1953).

530.145

3856. Conservation of quanta for nonlocal fields. C. GREGORY. *Phys. Rev.*, **89**, 1199 (*March* 15, 1953).

A definition of spatio and/or temporal integration of non-local expressions is set forth. The latter is applied to the computation of the momentum-energy vector and an invariant from non-local expressions

corresponding to the stress-energy momentum tensor and a four-vector. The latter four-vector is interpreted to be the quantum current density, and the invariant surface integral of this four-vector over a space-like surface is associated with the operator for the number of quanta. Application to a massless boson field leads to the conclusion that only the energy is positive definite, while the operator for the number of quanta is not, even though the boson field is real (Hermitian). In the usual quantum theory of fields a four-vector current exists only for complex fields. A.

530.145

3857. On the commutation relations and vacuum expectation values in the quantum theory of fields. P. JAUHO. *Ann. Acad. Sci. Fennicae, A I, No.* 127, 7 *pp.* (1952).

The requirements of covariance are shown to restrict the form of the commutation relations and vacuum expectation values for non-interacting fields to those of the type already used, so that a relativistically invariant cut-off procedure may not be achieved by modification of these. R. H. DALITZ

530.145

3858. New equation in the affine field laws. G. BANDYOPADHYAY. Letter in *Phys. Rev.*, **89**, 1161 (*March* 1, 1953).

The proposed field equations are obtained from two variational principles, of which one is that already given by Schrödinger [Abstr. 1122 (1947)]. These equations have Einstein's strong field equations as a limit case, but do not permit existence of an isolated magnetic pole. R. H. DALITZ

530.145

3859. On optics in generalized field theories. O. BERGMANN. *Acta phys. Austriaca*, **6**, *No.* 4, 306–18 (1953) *In German.*

Investigates the propagation of weak light waves in a local Galilean system for Schrödinger's field theory [Abstr. 6019 (1951)] in which electrodynamics is non-linear. An anisotropy in space is produced by a given uniform e.m. field and the resulting ellipsoidal ray surface is discussed. The abnormal propagation found by Hittmair and Schrödinger [Abstr. 2403 (1952)] is obtained as a special case, and the relationships between E, D, H, B and the ray vector are discussed. R. H. DALITZ

530.145

3860. Excited states of elementary particle and the quantization of elementary particles. M. SUGAWARA. Letter in *Progr. theor. Phys.*, **7**, 599–601 (*May–June*, 1952).

It is suggested that the V^0 particle is an excited state of the nucleon which decays emitting π-mesons. The μ-meson would be an excited state of a neutrino decaying by electron-neutrino pair creation.

W. J. SWIATECKI

530.145

3861. A generalized method of field quantization. H. S. GREEN. *Phys. Rev.*, **90**, 270–3 (*April* 15, 1953).

A method of field quantization is investigated which is more general than the usual methods of quantization in accordance with Bose or Fermi statistics, though these are included in the scheme. The commutation properties and matrix representations of the quantized field amplitudes are determined, and the energy levels of the field are derived in the usual way. It is shown that spin-half fields can be quantized in such a way that an arbitrary finite number of particles can exist in each eigenstate. With the generalized statistics, the interchange of two particles of the same kind may or may not be physically significant, according to the type of interaction by means of which they are created or annihilated. Physical consequences of the assumption that there are particles which obey the generalized statistics are briefly examined. A.

530.145

3862. Investigation of a logical quantum dynamics of electrons. I. S. C. KAR. *Bull. Calcutta Math. Soc.*, **44**, 1–21 (*March*, 1952) *In German.*

The equations of the classical Hamilton–Jacobi dynamics of electrons are derived, and transformed by a Lorentz transformation. This leads to the "logical" quantum dynamics of electrons. Agreement with classical dynamics is obtained in the zero approximation ($h \to 0$). The quantized Hamilton–Jacobi equations are stated in the Dirac–Weyl form and also in the Pauli form, and the corresponding path equations are derived. The failure of the causality principle is discussed. L. S. GODDARD

530.145

3863. Convergence problem in quantum electrodynamics. Y. KATAYAMA AND K. YAMAZAKI. Letter in *Progr. theor. Phys.*, **7**, 601–2 (*May–June*, 1952).

Some remarks on the expansion of solutions in quantum electrodynamics in powers of e^2, based on some analytic considerations equivalent to neglecting vacuum polarization and assuming all other diagrams of a given order in e to contribute equally.

R. H. DALITZ

530.145

3864. Quantum electrodynamics. R. KARPLUS. *J. Opt. Soc. Amer.*, **43**, 237–9 (*April*, 1953).

The interaction of the quantized electromagnetic field with charged particles is discussed from the point of view of hole theory and of electron-positron theory. The analogy of the energy-band structure of the vacuum and a semiconductor is pointed out. The interaction is seen to lead to scattering and to pair creation and annihilation, but it also gives rise to self-interactions that can be described as a change in the mass and in the magnetic moment of the electron. The fact that the mass change is infinite comprises one of the fundamental inconsistencies of the theory. Finally, the occurrence of non-linearities in the field equation results in the prediction of the scattering of light by light. A.

530.145

3865. A nonperturbation approach to quantum electrodynamics. S. F. EDWARDS. *Phys. Rev.*, **90**, 284–91 (*April* 15, 1953).

The equations governing the interaction of an electron with the electromagnetic fields are used in the form given by Schwinger to derive a linear integral equation for the function Γ, whose kernel is expressed as a power series in α. The first approximation to this

kernel is used and the resulting integral equation solved without recourse to perturbation theory. With the aid of the solution first approximations can be found for self-energy effects, which are now finite, and some discussion of the analytic behaviour of these and related quantities is given. An application of the method to meson theory illustrates the classification of the types of integral equation which arise. The possibility of extending the method is discussed. A.

530.145

3866. Remark on the self energy problem of the photon. O. HARA AND H. SHIMAZU. Letter in *Progr. theor. Phys.*, **7**, 591–2 (*May–June*, 1952).

Suggests that the photon interaction with the electron-positron field produces both a photon self-energy and an alteration of the photon propagation velocity, and that introduction of a counter term for the latter will ensure a zero photon self-energy.

R. H. DALITZ

530.145

3867. Symmetry properties of a universal interaction. D. L. PURSEY. *Physica*, **18**, 1017–19 (*Dec.*, 1952).

The only linearly independent Fermi interactions involving just two charged fields, satisfying charge conservation, and symmetrical w.r.t. interchange of the neutral fields (assuming anticommuting spinors) are $S - T + P$ and $V - A$. R. H. DALITZ

530.145

3868. Universal Fermi-type interaction. E. R. CAIANIELLO. *Physica*, **18**, 1020–2 (*Dec.*, 1952).

Discusses the possible universal four-fermion interactions satisfying simple symmetry principles and forbidding processes actually unobserved. Experiment still allows two of these possible principles, which lead to interactions $S - P \pm T$, between which observations on the μ-meson decay spectrum will be able to discriminate. R. H. DALITZ

530.145

3869. The production of bremsstrahlung in electron-electron collisions. M. L. G. REDHEAD. Letter in *Proc. Phys. Soc.* [*London*] *A*, **66**, 196–7 (*Feb.*, 1953).

Errors in a cross-section calculation by Katzenstein [Abstr. 5503 (1950)] are pointed out and a corrected result is given. J. J. WILKINS

530.145

3870. Radiative correction for the collision loss of heavy particles. V. Z. JANKUS. *Phys. Rev.*, **90**, 4–6 (*April* 1, 1953).

The correction to the Bethe–Bloch formula for the stopping power of fast heavy particles, due to virtual photons and the emission of real photons, has been computed using the Born approximation for the extreme relativistic case. The fractional correction increases with increasing energy of the incident particle. It is approximately 1% when the kinetic energy of the particle is 100 times its rest energy. A.

530.145

3871. On the equivalence principle. T. DODO AND R. UTIYAMA. Letter in *Progr. theor. Phys.*, **7**, 589–91 (*May–June*, 1952).

Demonstrates the equivalence theorem relating derivative and non-derivative couplings in some meson-nucleon theories by a change of variables in the Lagrangian, shown to be equivalent to a unitary transformation of the Hamiltonian. R. H. DALITZ

530.145

3872. Non-local theory of nucleon meson field. N. SHONO. Letter in *Progr. theor. Phys.*, **8**, 133–4 (*July*, 1952).

Summarizes a non-local meson-nucleon theory with pseudovector interaction, containing covariant structure functions for both nucleon and meson and for which the S-matrix is finite and its perturbation expansion claimed to be convergent. R. H. DALITZ

530.145

3873. A new quaternion approach to meson theory. C. W. KILMISTER. *Proc. Roy. Irish Acad.*, *A*, **55**, *No.* 5, 73–99 (*Jan.*, 1953).

The Clifford algebras C_{2n}, which form the natural generalizations of quaternions (C_2) are considered for $n = 2$ (E-numbers) and $n = 4$ (EF-numbers). Eddington's method (1936) of deriving Dirac's equation is extended and the resulting wave equation $E_\mu \partial_\mu \Psi = \kappa \Psi$, where Ψ is an E-number, is shown to be equivalent to the field equations for particles of spin 0 and 1. An analysis of the concept of field-free conditions justifies the usual representation in wave equations except for the particle with spin $\frac{1}{2}$ and 0 rest mass. It appears that there may be essentially different particle formulations of a given field theory.

W. J. SWIATECKI

530.145

3874. Nuclear forces from pseudoscalar meson theory. M. RUDERMAN. *Phys. Rev.*, **90**, 183–5 (*April* 15, 1953).

Radiative corrections are calculated for the interaction of two nucleons through pseudoscalar coupled mesons. After renormalization, these are very large for the usual magnitude of coupling constant, but do not change the range of the potential or its shape at large distances. The tensor part of the nuclear force is relatively insensitive to these corrections. A.

530.145

3875. Symmetric pseudoscalar theory of nuclear forces. A. KLEIN. Letter in *Phys. Rev.*, **89**, 1158 (*March* 1, 1953).

Reports a number of errors in the nucleon-nucleon potential derived from symmetric pseudoscalar meson theory by Levy [Abstr. 621 (1953)] and gives the correct fourth-order adiabatic potential $V_4(r)$. The sixth- and eighth-order potentials are also written down. R. H. DALITZ

530.145

3876. The charge independence of nuclear forces. D. FELDMAN. Letter in *Phys. Rev.*, **89**, 1159–60 (*March* 1, 1953).

When one compares reactions differing only as to charge assignments there follow restrictive inequalities for the cross-sections which must be satisfied for charge independence. In the case of nucleon scattering one finds, e.g. $(\sigma_{np})^{\frac{1}{2}} + (\sigma_{pn})^{\frac{1}{2}} \geqslant (\sigma_{pp})^{\frac{1}{2}}$, etc.

W. J. SWIATECKI

530.145

3877. Note on the non-relativistic limit of the Compton scattering. S. GOTO. Letter in *Progr. theor. Phys.*, **7**, 585–6 (*May–June*, 1952).

From Lorentz covariance and gauge invariance, it

is shown that the cross-section for Compton scattering, including all radiative corrections, approaches the Thomson scattering cross-section for photons of sufficiently low energy. R. H. DALITZ

530.145

3878. Pseudoscalar meson field and the scattering of fast neutrons by protons. N. C. SIL. *Indian J. Phys.*, **26**, 269–75 (*June*, 1952).

The differential cross-sections for the neutron-proton scattering, as calculated on the basis of the symmetrical, Serber's and charged combinations of pseudoscalar meson field with pseudovector interaction, have been compared with recent experimental findings. The effect of the elimination of the contact potential (δ-function type) and the influence of the tensor force terms upon the differential scattering cross-section have been investigated. A.

530.145

3879. Pseudoscalar meson field and relativistic scattering of neutrons by protons. D. BASU. *Indian J. Phys.*, **26**, 291–6 (*June*, 1952).

The relativistic expression for the differential cross-section of neutron-proton scattering is calculated for the pseudoscalar meson field with Serber charge combination and charge symmetrical theory. A comparison with the experimental results of *n-p* scattering at 90 and 260 MeV shows that Serber charge combination approaches the experimental curve more nearly than the charge symmetrical theory, and further the angular anisotropy of the *n-p* scattering decreases with increasing energy, whereas experimentally the same quantity increases with increasing energy. A.

530.145

3880. The asymptotic solution of an equation occurring in scattering theory. G. A. ERSKINE AND M. J. SEATON. Letter in *Proc. Phys. Soc.* [*London*] *A*, **66**, 123–4 (*Jan.*, 1953).

A well-known integral expression for the scattering amplitude based on the use of a Green's function solution of the Schrödinger equation is generalized to the case when the potential contains an integral operator and the theory of the Green's function ceases to hold. W. J. SWIATECKI

530.145

3881. Molière's theory of multiple scattering. H. A. BETHE. *Phys. Rev.*, **89**, 1256–66 (*March* 15, 1953).

Molière's theory of multiple scattering of electrons and other charged particles is here derived in a mathematically simpler way. The differential scattering law enters the theory only through a single parameter, the screening angle χ_a'. The angular distribution, except for the absolute scale of angles, depends again only on a single parameter b. It is shown that b depends essentially only on the thickness of the scattering foil in g/cm^2, and is nearly independent of Z. The transition to single scattering is reinvestigated. An asymptotic formula is obtained which agrees essentially with that of Molière, Snyder and Scott, but which remains accurate down to smaller angles. The theory of Goudsmit and Saunderson has a close quantitative relation to that of Molière, and a good approximation to their distribution function can be obtained by multiplying Molière's function by $(\theta/\sin\theta)$. This relation holds until the scattering angles become so large that only very few terms in the series of Goudsmit and Saunderson need to be taken into account. A.

530.145

3882. Applications of variational principles to scattering problems. S. ALTSHULER. *Phys. Rev.*, **89**, 1278–83 (*March* 15, 1953).

The Schwinger variational principle is reduced to a convenient form by using trial solutions of the form $\Sigma_i c_i u_i(x)$. The reliability of the formalism for polynomial trial solutions is studied for several fields, and wherever possible comparisons are made with phase shifts determined from other variational principles. The forward scattering amplitude is determined variationally for scattering in the static field of the hydrogen atom, and it is demonstrated that the undisturbed wave as trial solution provides more accurate results for all incident energies than second Born approximation. The improved variational estimate of the total cross-section for this field approaches that of Born at the higher energies. A.

530.145

3883. On the coherent scattering of light by an electrostatic field according to the Dirac hole theory. P. SVENONIUS. *Ark. Fys.*, **6**, *Paper* 27, 269–77 (1953).

The S-matrix element for scattering of a photon by an electrostatic field V is obtained to lowest order in V, using non-covariant perturbation theory. The spur calculation is outlined and the non-relativistic approximation discussed. R. H. DALITZ

530.145

3884. Steady states and the S-matrix. J. HAMILTON. *Proc. Cambridge Phil. Soc.*, **49**, *Pt* 1, 97–102 (1953).

The relation between the bound states of two interacting particles and the S-matrix is discussed. The relevant terms of the S-matrix are resolved into an infinite product of operators. Capture and emission problems are discussed. A.

530.145

3885. Divergence of perturbation expansion. A. PETERMANN. Letter in *Phys. Rev.*, **89**, 1160–1 (*March* 1, 1953).

The contribution of the pattern graphs to the nth term of the expansion of the Green's function in powers of the coupling constant is estimated, and the total contribution of all such graphs shown to be given by a divergent series. R. H. DALITZ

530.145

3886. The solution of the Schrödinger equation for finite systems, with special reference to the motion of electrons in Coulomb electric fields and uniform magnetic fields. R. B. DINGLE. *Proc. Cambridge Phil. Soc.*, **49**, *Pt* 1, 103–14 (1953).

A number of methods are formulated for solving the Schrödinger equation for systems of finite extent. The methods are developed in detail for the particular case of an electron moving in a Coulomb field (e.g. hydrogen-like atom), with a boundary consisting of a sphere of given radius. In the second part of the paper these results are transformed into those for an electron moving in a uniform magnetic field, the boundary of the system being cylindrical. A.

530.145

3887. On the Schrödinger–Gordon equation. K. F. NOVOBATZKY. *Ann. Phys.* [*Leipzig*] **11,** *No.* 4–7, 285–92 (1953) *In German.*

The considerations of a previous paper [Abstr. 2410 (1952)], relating the unrelativistic Schrödinger equation to a statistical assembly based on a Hamilton–Jacobi equation with an additional "quantum mechanical density potential," are extended to the relativistic second-order wave equation. W. A. HEPNER

GENERAL MECHANICS . MECHANICS OF SOLIDS 531

531.25

3888. On a routine analytic method for the solution of problems in statics. A. W. SIMON. *Amer. J. Phys.*, **21,** 244–6 (*April*, 1953).

A routine analytic method for the solution of problems in statics is given. The method requires no geometry other than that required for the identification of the co-ordinates of certain cardinal points involved in the problem. The method is illustrated by the detailed solution of an actual case. A.

531.38

3889. Rocking experiment with two degrees of freedom. J. SATTERLY. *Amer. J. Phys.*, **21,** 267–73 (*April*, 1953).

A ring stands, with axis horizontal, on a horizontal table and a cylinder is placed, also with axis horizontal, resting within it. If motion in the same horizontal direction be given to both, they both roll and the motion is of no particular interest. If, however, motion in opposite directions be given to the ring and the cylinder "rocking" occurs, this motion is interesting because its theoretical solution involves the use of Lagrangian equations, there being two degrees of freedom. Theory and experiment are here given for rings (thin and thick, complete and semi-circular) and cylinders (hollow and solid) of different sizes. Good agreement is observed. A.

531.394

3890. Longitudinal vibrations of a vertical column by the method of Laplace transform. L. H. HALL. *Amer. J. Phys.*, **21,** 287–93 (*April*, 1953).

An interesting illustrative problem in mechanics is the motion executed by a vertical rod or column when it suffers sudden loss of support at the bottom. A solution is presented by the method of Laplace transform in two alternative forms: one represents the motion as a superposition of free fall and two oppositely directed progressive waves equal in amplitude and form; the other, as a free fall and a pulse, initiated at the bottom and propagated up and down the column upon reflection at the ends. A.

531.551 : 530.12

3891. Relativistic rocket theory. W. L. BADE. *Amer. J. Phys.*, **21,** 310–12 (*April*, 1953).

In the relativistic theory of one-dimensional rocket motion in empty space, Ackeret has found the differential equation of motion and the mass-ratio formula. One can obtain a formal solution for the integrated equation of motion $X = X(T)$ in the general case by determining X and T parametrically as functions of the proper time s of the rocket. A.

531.57 : 539.215.9

3892. Surface energy, a mode for energy absorption during impact. J. S. RINEHART. *Amer. J. Phys.*, **21,** 305–7 (*April*, 1953).

The role that pulverization of the target material may play in absorbing the energy of an impacting missile is discussed. The energy that can be absorbed in this way will, in general, depend on the area of new surface that is created. Approximate calculations suggest that, for impacts against rock-like materials and glass, very considerable amounts of energy could be absorbed. The production of rock flour at the Barringer Meteorite Crater in Arizona is cited as an example. A.

MECHANICAL MEASUREMENTS 531.7

531.714.7

3893. Device for position location. A. MIRAU. *Rev. Opt.*, **31,** 457–8 (*Oct.*, 1952) *In French.*

Application to a micrometer eye-piece is described. A.

531.768 : 621.317.79

3894. Accelerometers. H. WILDE. *Arch. tech. Messen, Issue* 201 (*Ref. J*163–3), 229–34 (*Oct.*, 1952) *In German.*

Descriptions are given of many of the forms of accelerometer commonly available including the electromagnetic displacement meter feeding into a doubly differentiating circuit, the electromagnetic velocity meter associated with a single stage of differentiation, a mass attached to a spring carrying a wire strain gauge, the piezoelectric instrument in which a mass exerts pressure on a quartz crystal, and the magnetostrictive type of instrument. Indications are given of the characteristics of these instruments and of the frequency ranges in which they are commonly used. Mention is made of limit indicating accelerometers in which, when the movement of the mass exceeds a given value, that is when the acceleration exceeds a definite value, contacts are closed and the fact is recorded electrically. A. C. WHIFFIN

531.788.6 : 621.317.79

3895. An electrical manometer for gas pressures up to 40 mm of mercury. F. H. REYNOLDS. *J. sci. Instrum.*, **30,** 92–6 (*March*, 1953).

Equations are derived for the heat interchange at the surface of a straight hot wire in a gas, and from them gas pressure is plotted as a function of temperature for various currents and for Ne, A and H. Sensitivity is also plotted and the curves show that Ne and A have max. sensitivities at low filament currents but that sensitivities vary considerably with gas pressure, p. At higher currents (~1A) the sensitivity, although lower, is still sufficient and is almost independent of p. The curves for H show greater variations as well as non-linearity. The

results were used as the basis for the design of a Pirani type gauge, using a helical wire. To obtain consistent results, a water jacket was provided around the envelope. In use the gauge forms an arm of a bridge, with a sealed-off gauge in an adjacent arm. The gauge non-linearity is compensated by a metal rectifier. Calibration curves are given and instability occurring at low currents and pressures is discussed. W. G. STRIPP

531.791

3896. Coincidence and overlap errors in the automatic counting and sizing of particles. J. R. HODKINSON. Letter in *Nature* [*London*] **171,** 351–2 (*Feb.* 21, 1953).

Formulae are deduced for the coincidence error under various conditions and applied to particular cases of coal-mine dust samples. S. WEINTROUB

MECHANICS OF FLUIDS 532

532.1 : 532.61

3897. The stress tensor, surface tension and viscosity. A. G. MCLELLAN. *Proc. Roy. Soc. A*, **217,** 92–6 (*March* 24, 1953).

A general expression for the stress tensor in terms of the pair-distribution function is found, which is valid for classical or quantum mechanics. This expression provides a simple method of obtaining known results such as the kinetic pressure and the coefficient of viscosity. The principal application is to the derivation of an expression for the tension of a spherical surface. A.

532.12 : 534.23 : 539.32

3898. Internal pressure. R. AUERBACH. *Kolloid Z.*, **118,** 55–6 (1950) *In German.*

From the empirical relation $B = 260\sigma^{2/5}\rho^{1/3}$ (atm.) between the internal pressure B, surface tension σ, and ρ of a liquid, and the relation previously established between ρ and the velocity of sound in a liquid, it is deduced that B is $\propto$ the acoustic resistance. Relations between B and the elastic modulus of a solid or the compressibility of a liquid are deduced. BRITISH ABSTRACTS

532.13

3899. Viscosity as a material constant. H. UMSTÄTTER. *Kolloid Z.*, **126,** 108–20 (1952) *In German.*

The visco-elastic behaviour of non-Newtonian liquids is considered. The integration of the Maxwell equation with respect to time and the representation of the results by three-dimensional diagrams are discussed. Periodic deformations are treated in terms of the apparent η, apparent elasticity and relaxation time. Incomplete relaxation is the main cause of visco-elastic hysteresis. At high frequencies the compressibility must be considered, and longitudinal as well as transverse waves are possible. Behaviour under these conditions is analysed in terms of the Young's and Lamé's moduli, and the Poisson contraction number. BRITISH ABSTRACTS

532.13 : 541.64

3900. Bulk viscosity of the system polystyrene/diethyl benzene. F. BUECHE. *J. appl. Phys.*, **24,** 423–7 (*April*, 1953).

The bulk viscosity has been measured over the concentration range from 8 to 80 weight % polymer and a temperature range from 30 to 130°c. A single sample of polymer was used. The activation energy for viscous flow is found to vary from about 2 to 100 kcal/mole as one goes from pure solvent to pure polymer. Using a series of 15 fractions of polystyrene ranging from 50 000 to 10^6, the molecular weight dependence for the viscosity of this system was measured at two polymer concentrations, 14 and 44%. The results are compared in a qualitative way with what one would expect from existing theory. A.

532.133 : 541.133

An extension of the theory of the conductivity and viscosity of electrolyte solutions. *See Abstr.* 4445

532.137

3901. The band viscometer. H. H. HULL. *J. Colloid Sci.*, **7,** 316–22 (*June*, 1952).

A band viscometer [Wachholtz and Asbeck, Abstr. 2191 (1942)] operating up to rates of shear of 10 000 sec^{-1} is described, and results for two near-Newtonian fluids, Silicone fluid 200 and four colour oil inks, are shown graphically. J. E. CAFFYN

532.5 : 538.3

Steady motion of conducting fluids in pipes under transverse magnetic fields. *See Abstr.* 4220

532.51

3902. On unsteady flow of compressible viscous fluids. G. LUDFORD, H. POLACHEK AND R. J. SEEGER. *J. appl. Phys.*, **24,** 490–5 (*April*, 1953).

In order to solve the non-linear equations of fluid dynamics, classical hydrodynamics introduced the concept of perfect incompressible fluids, viz. the perfect inviscid fluid and the perfect viscous fluid. The practical importance of considering compressibility nowadays has resulted in two new approaches from two distinct points of view. In the one case, compressibility is included in the discussion of a perfect inviscid fluid. As is well known, however, compressible effects include shock-wave phenomena, which are regarded in this instance as mathematical discontinuities. The goal then is to study the basic equations, allowing discontinuous solutions. The other approach retains the viscous terms together with the compressible ones. It is based upon the possibility of small coefficients producing large changes in the behaviour of the solutions. The present paper is written from this point of view. The consequent mathematical difficulties of solving the equations are avoided by the use of a particle model of the continuum. The resulting equations are put into finite difference form for solution on a digital calculator. A.

532.51

3903. Stability of plane parallel flows of electrically conducting fluids. D. H. MICHAEL. Note in *Proc. Cambridge Phil. Soc.*, **49,** *Pt* 1, 166–8 (1953).

Squire has shown (1933) that if a velocity profile becomes unstable to a small three-dimensional disturbance at a given Reynolds number, then it will

become unstable to a small two-dimensional disturbance at a lower Reynolds number. It follows that the investigation of stability can be restricted to cases of two-dimensional disturbances. It is now shown that Squire's result remains true when a uniform magnetic field is applied parallel to the flow between two perfectly conducting planes, and small disturbances of both the velocity and magnetic field take place. In particular, it is shown that a steady flow in a uniform field cannot be unstable to a purely magnetic disturbance. J. S. G. THOMAS

532.51

3904. Note on Stokes's stream function for motion with a spherical boundary. S. F. J. BUTLER. Note in *Proc. Cambridge Phil. Soc.*, **49**, *Pt* 1, 169–74 (1953).

The circle theorem of Milne-Thomson (1940) connecting the complex potential in a two-dimensional irrotational flow about a circular cylinder with that of the flow when the cylinder is absent has a three-dimensional counterpart in Weiss's result (1944) for the perturbed velocity potential in an unlimited irrotational flow when the rigid boundary $r = a$ is introduced. The perturbed Stokes stream function for axi-symmetric motion within or outside the rigid spherical boundary $r = a$ is now established. Weiss's velocity potential result, not being restricted to axi-symmetric motion, has wider application than the present result. Proofs of the two sphere theorems depend upon an inversion theorem for Stokes's stream function $\psi(r, \theta)$, analogous to Kelvin's inversion theorem for harmonic functions. The following cases are briefly discussed: (1) a source outside a sphere; (2) a radial line segment source outside a sphere; (3) a circular vortex filament outside a sphere, centred on its axis; (4) a radial doublet within a sphere; (5) equal source and sink on the same diameter within a sphere; and (6) a source and radial line sink on the same diameter within a sphere; equations of the stream sheets are deduced in all cases. J. S. G. THOMAS

532.51 : 538.65

3905. The stability of viscous flow between rotating cylinders in the presence of a magnetic field. S. CHANDRASEKHAR. *Proc. Roy. Soc. A*, **216**, 293–309 (*Feb.* 10, 1953).

The theory of the stability of viscous flow between two rotating coaxial cylinders which has been developed by Taylor (1923), Jeffreys (1928) and Meksyn (1946) is extended to the case when the fluid considered is an electrical conductor and a magnetic field along the axis of the cylinders is present. A differential equation of order eight is derived which governs the situation in marginal stability; and a significant set of boundary conditions for the problem is formulated. The case when the two cylinders are rotating in the same direction and the difference (d) in their radii is small compared to their mean (R_0) is investigated in detail. A variational procedure for solving the underlying characteristic value problem and determining the critical Taylor numbers for the onset of instability is described. As in the case of thermal instability of a horizontal layer of fluid heated below [Abstr. 6456 (1952)], the effect of the magnetic field is to inhibit the onset of instability, the inhibiting effect being the greater, the greater the strength of the field and the value of the electrical conductivity. In both cases, the inhibiting effect of the magnetic field depends on the strength of the field (H), the density (ρ) and the coefficients of electrical conductivity (σ), kinematic viscosity (ν) and magnetic permeability (μ) through the same non-dimensional combination $Q = \mu^2 H^2 d^2 \sigma / \rho \nu$; however, the effect on rotational stability is more pronounced than on thermal instability. A table of the critical Taylor numbers for various values of Q is provided. A.

532.517

3906. A spherical obstacle in the flow of a viscous fluid through a tube. S. WAKIYA. *J. Phys. Soc. Japan*, **8**, 254–7 (*March–April*, 1953).

The Poiseuille flow through a circular tube as affected by the presence of a fixed spherical obstacle with its centre on the axis of the tube is considered on the basis of the Stokes approximation. Expressions for the resultant force acting on the sphere and for the pressure difference which must be added to maintain the total flux through the tube at the value corresponding to the case of absence of the obstacle are obtained correctly to $(a/r_0)^5$, where a and r_0 are the radii of the sphere and the tube respectively. If terms of the order of $(a/r_0)^2$ can be neglected, the magnitude of the resistance is shown to be equal to that of a sphere moving with a constant velocity along the axis of a tube, which was first obtained by Ladenburg. A.

532.517

3907. Extension of Heisenberg's model of turbulence to critical Reynolds numbers. E. N. PARKER. *Phys. Rev.*, **90**, 221–3 (*April* 15, 1953).

By considering a few extra physical complications introduced by the presence of boundaries, small velocities, etc., it is possible to extend Heisenberg's methods to the calculation of critical Reynolds numbers. Calculations are carried out for Couette, plane Poiseuille and Blasius flow. The results are found to be within about 20% of the observed values. A.

532.525

3908. Sensitive bubble jets. K. E. SPELLS. Letter in *Proc. Phys. Soc.* [*London*] *B*, **66**, 258–9 (*March*, 1953).

It has been shown that the bubbling process associated with the rapid flow of air through vertical rectangular slots submerged in water, is affected by sound at frequencies corresponding to first-order resonance in the air column of the slotted tube, and at a higher frequency independent of the tube length and probably associated with some other part of the apparatus used [see Smith, *Phil. Mag.*, **19**, 1147 (1935). Abstr. 3588 (1935)]. J. S. C. THOMAS

532.528

3909. The stability of the surface of a cavitation bubble. A. M. BINNIE. *Proc. Cambridge Phil. Soc.*, **49**, *Pt* 1, 151–5 (1953).

A theoretical examination is made of the stability of a spherical interface between two inviscid liquids accelerated radially from rest. If surface tension be neglected, it is found that the interface is unstable or

stable according as the acceleration is directed towards or away from the liquid of greater density. Surface tension has a marked stabilizing effect, and numerical results are given for the minimum outward acceleration required to destroy the equilibrium of the surface of a cavity formed in water. These results are suggested as a possible explanation of the behaviour of cavitation bubbles seen to form near a fixed object under test in a water tunnel. A.

532.58

3910. The self-propulsion of microscopic organisms through liquids. G. J. HANCOCK. *Proc. Roy. Soc. A*, **217**, 96–121 (*March* 24, 1953).

Since the Reynolds number of motion of microscopic organisms through liquids, defined as $L\rho V/\mu$, where L is the length of the organism, V the velocity with which it moves, ρ the density of the liquid and μ the viscosity, is small, propulsion is due predominantly to the viscous forces, the effect of the inertial forces being negligible. The best-known problem that neglects all inertial forces is Stokes's solution for the slow steady fluid motion past a sphere, in which the velocity field can be described in terms of singularities situated at the centre of the sphere. The movement of microscopic organisms is determined by placing distributions of these singularities inside the surface of the organism and satisfying all boundary conditions. The motions that are considered are restricted to organisms which propagate some kind of disturbance along filaments of circular cross-section with small radius. The first problem to be considered is that of an infinite thin filament along which are propagated plane waves of lateral displacement. Formulae for the velocity of propulsion are obtained for (i) the limiting case of zero radius and (ii) the case when the amplitude of the displacement is small compared to the wavelength. Computations have been carried out to estimate the propulsion in the case of small non-zero filament radius when the amplitude is larger than that allowed for in case (ii) above. It is also shown that the propulsion of a finite filament which forms itself into a single wave is very near to that of an infinite filament with the same wave motion. The second problem is that of an infinite filament along which any general three-dimensional disturbance is propagated. The movement is then deduced for the propagation of a spiral wave along an infinite filament, and also for the propagation of longitudinal waves along a finite filament. See also Abstr. 7988 (1952). A.

532.59

3911. Mass transport in gravity waves. F. URSELL. *Proc. Cambridge Phil. Soc.*, **49**, *Pt* 1, 145–50 (1953).

A proof is given of the existence of a slow drift associated with the passage of gravity waves over the surface of a frictionless fluid when the wave motion is irrotational. The drift is in the direction of propagation and is greatest near the surface, decreasing steadily towards the bottom, where it may be negative if the fluid is of finite depth. The particle displacement due to a solitary wave has similar properties. The proof confirms the approximate calculations of Stokes and extends the proof of Rayleigh, applicable only to deep water. A.

532.59 : 621.317.79

3912. Instrument for recording of ripples in water level. W. OESTERLIN. *Arch. tech. Messen, Issue No.* 202 (*Ref. V*1123–12) 241–4 (*Nov.*, 1952) *In German.*

Deals with the principle, design and limitations of an instrument for measuring and recording ripples in water level (e.g. in a test tank). The instrument incorporates two electrodes submerged into the water and carrying a.c. The conductivity between the electrodes is proportional to the extent of submersion. J. VAN WAASDIJK (R.)

532.61 : 539.4.01

3913. The limiting negative pressure of mercury in Pyrex glass. L. J. BRIGGS. *J. appl. Phys.*, **24**, 488–90 (*April*, 1953).

It is generally considered that mercury does not "wet" glass, as evidenced by the convex surface of the mercury meniscus in a manometer. If this were true under all conditions, the development of a negative pressure in a mercury column would be impossible. But pure mercury in a clean evacuated degassed tube shows a flat meniscus. In other words, when the tube is degassed, mercury does adhere to the glass wall. A U-tube manometer of 5-mm bore with one leg sealed off was evacuated and degassed at 500°C with a mercury-vapour pump, and then filled with pure mercury by distillation. The vertical height of the mercury column from the meniscus in the open tube to the top of the closed leg was 52 cm. When the manometer was again evacuated, the mercury column remained suspended from the top of the tube, withstanding a negative pressure of two-thirds of an atmosphere. In extending the measurements, short mercurial thermometers were first used. Each thermometer was cemented to the spinner of a variable-speed motor, with the spin axis bisecting the distance from the end of the bulb to the meniscus. The maximum centrifugal stress on the free capillary column was consequently at the spin axis. Measurement of nine thermometers gave negative pressures ranging from 2 to 17 bars. Finally, freshly drawn capillary tubes with fine bores were evacuated, degassed by heating, sealed off and filled by breaking one end under pure mercury. The negative pressure which these mercury columns could withstand under centrifugal stress increased rapidly as the degassing improved. The highest negative pressure observed for mercury was 425 bars at 28°C. In this case, the furnace temperature during degassing was raised to the point where the capillary tube started to deform. A.

532.61.08

3914. The determination of surface tension by sessile drop measurements, with application to mercury. G. M. ZIESING. *Austral. J. Phys.*, **6**, 86–95 (*March*, 1953).

The error in the Worthington (1885) sessile drop equation, as an approximation to the exact equation from which it was derived, is found to be of the order of experimental errors in recent surface tension determinations. The source of error and origin of the optical band system observed when parallel light is used to define the summit of a sessile drop have been investigated. The band system is shown to originate

in an interference phenomenon from the curved surface of the drop. Detailed descriptions are given of the cleaning and testing methods necessary for the preparation of mercury and glassware involved in the determination of the surface tension of mercury as $484{\cdot}9 \pm 1{\cdot}8$ dyn/cm. A lower limit to the temperature coefficient of the surface tension was set at 0·20 dyn/cm °C. A.

532.61.08

3915. Determination of the coefficient of surface tension by the bubble length method. J. C. Slonczewski and R. Heller. *Amer. J. Phys.*, **21**, 313–14 (*April*, 1953).

The method of Everard and Hurley (1944) is confirmed with twelve liquids. The overall length l of an air bubble of given volume V is measured in a horizontal tube of known internal diameter $2r$. The equation $\rho g/2\gamma = Al + B$ holds; A and B are obtained by calibrating with known liquids (ρ = density; γ = surface tension). S. J. GREGG

MOLECULAR THEORY OF LIQUIDS 532.7

532.7

3916. On the application of the cell method to *r*-mer liquids. I. Prigogine, N. Trappeniers and V. Mathot. Letter in *J. chem. Phys.*, **21**, 559–60 (*March*, 1953).

The cell theory of liquids applies only (Lennard Jones–Devonshire) to molecules with approximately spherical symmetry. The authors extend it to r-mer molecules, visualizing the r-mer as an assembly of r point centres linked by valence forces, and assuming that the N molecules of the liquid can be arranged on a quasi-crystalline lattice. The partition function is derived, and there is indirect comparison with experiment which shows good agreement. T. C. TOYE

532.7

3917. On the statistical theory of *r*-mer solutions. I. Prigogine, V. Mathot and N. Trappeniers. Letter in *J. chem. Phys.*, **21**, 560–1 (*March*, 1953).

The assumption is made that both monomer and r-mer molecules can be arranged on a quasi-crystalline lattice; r-mer solutions are then generally treated, accounting for the combinatory effects, as well as the changes due to mixing, in the partition functions of the components. A fuller report is in preparation. T. C. TOYE

532.7

3918. Application of the cell model to the statistical thermodynamics of solutions. Volume change of mixing in solutions of molecules slightly different in size. I. Prigogine and A. Bellemans. Letter in *J. chem. Phys.*, **21**, 561–2 (*March*, 1953).

In a previous work [Abstr. 2686 (1952)] a condition that the radii were equal was made and a volume contraction on mixing of certain systems was predicted and found to agree with experiment. In general, however, this condition does not apply and it is shown that an expansion will occur. Agreement with experiment is indicated. T. C. TOYE

532.7 : 530.162 : 536.7

3919. Absorption of diatomic gas by binary alloys. I. T. Saito. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **3**, 502–12 (*Aug.*, 1951).

Experimental results previously reported on the absorption of N gas by molten binary alloys were considered from the viewpoint of statistical thermodynamics. According to the previous results, gas atoms α dissolved in the interlattice positions in quasi-crystal of molten alloy lattice are not distributed uniformly and the distribution depends upon the amount of interaction energies $\phi_{B\alpha}$ and $\phi_{A\alpha}$ of α-atom with metal atoms A and B; that is, N atoms have a tendency to cluster around Cr or Mn atoms when N is absorbed by molten Fe–Cr or Fe–Mn alloys. Taking the above-mentioned fact into account, the theoretical formula concerning the absorption of diatomic gas by binary alloys was derived. It could explain satisfactorily the results formerly obtained with respect to N absorption by molten Fe–Cr, Fe–Mn and Fe–Ni alloys. Further, the validity of the present theory was checked by some previous data on the absorption of diatomic gases (N, H or O) by binary solid solutions. A.

532.7 : 534.23

Symposium on ultrasonic absorption in fluids at Brown University (October, 1952). *See Abstr.* 3949

532.7 : 534.23

Ultrasonic absorption in liquid mixtures and structural effects. *See Abstr.* 3950

532.7 : 539.26

3920. On the atomic distribution curves for liquids. I. A comment on Sharrah and Gingrich's work on liquid oxygen. E. Kanda and T. Sugawara. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **3**, 34–8 (*Feb.*, 1951).

There are some questions concerning the interpretation of the second peak in the atomic distribution curve of liquid O published by Sharrah and Gingrich (1942). An attempt to determine O_3 content in liquid O exposed to X-rays was made, but an amount sufficient to make appreciable contributions to the X-ray diffraction intensity was not detected. From this result, Gingrich's interpretation that this peak originates from O_3, the amount being increased during the X-ray irradiation on liquid O, was contradicted. Possibilities of the explanation of this second peak and the like peaks in the distribution curves of liquid N and liquid Cl are suggested. A.

532.7 : 539.26

3921. On the atomic distribution curves for liquids. II. False details in the atomic distribution curves and their discrimination. T. Sugawara. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **3**, 39–49 (*Feb.*, 1951).

The origins of ghost peaks in the distribution curves of liquids obtained by X-ray diffraction experiments were studied in detail, and the most important origin was thought to be the fact that our intensity measurements were limited over a region of relatively small diffraction angles. This was verified by calculating intensity curves from a hypothetical radial distribution curve. Radial distribution curves obtained by Fourier transforms of the intensity function showed some false details which were not

found in the original curve. As an example, the small peak at 2·2 Å in the experimental distribution curve of liquid O was shown to be a ghost one as was suggested in Pt I. It was shown that these false details always appear in the cases of aggregates of atoms having small interatomic distances. A method for the discrimination of ghost peaks in such cases was described and applied to liquid O, N and Cl. The positions of ghost peaks calculated by this method were in fair agreement with those in the experimental distribution curves found in the literaures. A.

532.72

3922. The effect of pressure on diffusion in CS_2 organic mixtures. R. C. KOELLER AND H. G. DRICKAMER. *J. chem. Phys.*, **21**, 575–88 (*April*, 1953).

Diffusion coefficients are presented as a function of pressure to 10 000 atm. for the following systems:

50 mol % *n*-heptane—50% CS_2 0°–20°–40°;
50 mol % 2,4 dimethylpentane—50% CS_2 20°–40°;
50 mol % toluene—50% CS_2 20°–40°;
50 mol % methylcyclohexane—50% CS_2 0°–20°–40°;
50 mol % *n*-octane—50% CS_2 20°C;
50% chlorobenzene—50% CS_2 20°–40°;
80% chlorobenzene—20% CS_2 40°;
50% *n*-butanol—50% CS_2 20°–40°;
50% iso-butanol—50% CS_2 20°–40°;

using S^{35}-tagged CS_2. The results are interpreted in terms of the activation volume, enthalpy and entropy, and conclusions are drawn concerning the effect of pressure on the structure of the liquids. A.

532.72

3923. The effect of pressure on diffusion in water and in sulfate solutions. R. B. CUDDEBACK, R. C. KOELLER AND H. G. DRICKAMER. *J. chem. Phys.*, **21**, 589–97 (*April*, 1953).

Diffusion coefficients are presented as a function of pressure to 10 000 atm. for the following systems:

THO—H_2O 0°–25°–50°;
0·1N $H_2S^{35}O_4$—0·1N H_2SO_4 0°–5°–25°–50°;
0·1N $Na_2S^{35}O_4$—0·1N Na_2SO_4 0°–25°–50°;
1·0N $Na_2S^{35}O_4$—1·0N Na_2SO_4 0°–25°–50°;
0·1N $K_2S^{35}O_4$—0·1N K_2SO_4 0°–25°–50°.

The results are interpreted in terms of the activation volume and the tetrahedrally co-ordinated structure of water. It is found that pressure tends to break down the structure and in certain regions an increase in diffusion coefficient with pressure is noted. In the salt solutions the water structure is controlling with some added effects due to solvation and ionic interaction. A.

532.72

3924. The effect of pressure on diffusion in aqueous and alcoholic salt solutions. R. B. CUDDEBACK AND H. G. DRICKAMER. *J. chem. Phys.*, **21**, 597–601 (*April*, 1953).

Diffusion coefficients have been measured as a function of pressure to 10 000 atm for the following aqueous solutions:

0·1N $Hg(NO_3)_2$ at 0°, 25°, 50°, 75°C,
0·1N $CaCl_2$ at 25°, 50°C,
0·1N $Ca(NO_3)_2$ at 25°C,
0·1N $TlNO_3$ at 25°C,

and for 0·01M $HgCl_2$ in *n*-butanol at 25° and 50°C. The results are interpreted in terms of the activation volume, and compared with data on water and sulphate solutions (preceding abstract). A.

532.73–1 : 539.213

3925. A solubility determination of some elemental gases in Pyrex at 1170°C. J. J. NAUGHTON. Letter in *J. appl. Phys.*, **21**, 499–500 (*April*, 1953).

Solubility of H at 10 mm pressure is 0·060 ± 0·004 cm^3 (S.T.P.) per g of Pyrex. O, A and He show no measurable solubility at this pressure. R. O. DAVIES

MECHANICS OF GASES 533

533.16

3926. Measurement of viscosities of gases at high pressure. I. Viscosity of air at 50°, 100° and 150°C up to 200 atmospheres. H. IWASAKI. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **3**, 247–57 (*April*, 1951).

A modified oscillating disk viscometer was constructed to study the viscosities of gases at high pressures over a wide range of temperatures. Detailed accounts are given of the apparatus and of the method for calculating the viscosity from the experimental data. Results are given for the viscosity of air at 50°, 100° and 150°C up to 200 atmospheres to an accuracy of about 1%. A.

533.6.011

3927. A selection of tables for use in calculations of compressible flow. L. ROSENHEAD AND OTHERS. *London: Oxford University Press*, 143 + vii *pp.*

Review in *Phil. Mag.*, **44**, 232 (*Feb.*, 1953).

533.6.011.3

3928. On the limiting line in a simple wave. Z. HASIMOTO. *J. Phys. Soc. Japan*, **8**, 251–4 (*March–April*, 1953).

The condition in the neighbourhood of an envelope formed by the straight Mach lines in a simple wave is discussed, obtaining the result that at the envelope, which may be called a "limiting line" as in the case of ordinary flows other than simple waves, the cross Mach lines have a cusp and the distribution of the stream function along the cross Mach lines takes an extremum. A.

533.6.011.3

3929. On the subsonic flow of a compressible fluid past a prolate spheroid. K. HIDA. *J. Phys. Soc. Japan*, **8**, 257–64 (*March–April*, 1953).

The steady irrotational subsonic flow of a compressible fluid past a prolate spheroid is discussed by Janzen–Rayleigh's method and the velocity potential correct to M^2 is given in elliptic co-ordinates, where M is the Mach number for the undisturbed flow at infinity. Two cases are discussed in which $t = 0{\cdot}9$ and $0{\cdot}1$, t being the thickness-ratio of the body. In the former case the velocity distribution on the surface of the body is shown, while in the latter only the maximum velocity at the end of the minor-axis of the spheroid is given. The so-called critical Mach number, M_{crit}, at which the maximum fluid velocity in the field of flow first becomes equal to the local sound velocity, is also calculated in both cases and is found to be $M_{crit} = 0{\cdot}615$ and $0{\cdot}972$ respectively. In an appendix some numerical values of Legendre's

spherical functions $P_n(z)$ and $Q_n(z)$ ($n = 1 \sim 13$) are tabulated for various values of z ranging from 1·01 to 2. A.

533.6.011.4

3930. On the detachment of shock wave from the leading edge of a finite wedge. K. TAMADA. *J. Phys. Soc. Japan*, **8**, 242–7 (*March–April*, 1953).

An approximate analysis of the transition from attached to detached shock wave for the case of a finite wedge. Neglecting the vorticity, the flow behind the shock is expressed approximately by a velocity potential which consists of two parts, one corresponding to a uniform flow and the other to the perturbation flow respectively. The perturbation potential and the shape of the shock wave are determined simultaneously by a fundamental linearized equation in conjunction with appropriate boundary conditions on the shock wave and at the surface of the wedge. They are found to reveal characteristic singularities at the tip of the wedge. Some special treatment is needed for the extreme case of the detachment Mach number. Numerical computations are made for several Mach numbers on the shape of the shock wave and the velocity distributions along the side of the wedge. The drag coefficient of the wedge is also calculated as a function of the Mach number. The calculated value of the drag coefficient attains its maximum in the midst course of the transition. A.

533.6.011.4

3931. A note on cross Mach lines in simple waves in the plane supersonic flow. Z. HASIMOTO. *J. Phys. Soc. Japan*, **8**, 248–51 (*March–April*, 1953).

Explicit representation of cross Mach lines in simple waves has already been obtained for the case of polytropic gases. In the present paper, a more general expression is deduced without restriction to any special type of gases. It is also shown that the distribution of the stream function along a cross Mach line can be expressed in a very simple form. A.

MOLECULAR THEORY OF GASES 533.7

533.77 : 519.2

3932. The asymptotic expression for the structure function of interacting particles. H. MATSUDA. Letter in *Progr. theor. Phys.*, **81**, 136 (*July*, 1952).

The methods of the theory of probability are used to obtain a partial solution of the problem of finding the asymptotic expression as $N \to \infty$ for the volume in the configurational space of N particles of the set of points for which the configurational potential energy is less than a fixed value. E. H. SONDHEIMER

VIBRATIONS . ACOUSTICS 534

534.113

3933. Investigation of stress waves in cylindrical steel bars by means of wire strain gauges. S. PETERSSON. *K. Tekn. Högsk. Handl., No.* 62, 21 *pp.* (1953).

The Hopkinson pressure bar technique was employed in which a cylindrical steel bar, 25 mm dia. by 1 m long, was subjected at one end to the pressure of an exploding dynamite charge and the resulting stress wave was recorded by wire resistance strain gauges and an oscillograph. The duration of the pressure was less than 5 microsec and was thus less than the period of purely radial oscillations. The stress wave was flattened to a length of about 5 times the dia. of the bar and was followed by h.f. oscillations of 50 to 150 kc/s. These effects were studied experimentally and theoretically. Only the impulse of the pressure on the end of the bar could be determined unless the diameter of the bar was reduced or the size of charge increased. The h.f. oscillations become damped out after a few passages of the wave along the bar. The strain gauge cemented to the surface of the bar does not record the mean stress over the section. An indication proportional to the mean stress can be obtained from two gauges at right angles employed as two arms of the bridge circuit.

A. C. WHIFFIN

534.13 : 531.717

3934. Measurement of the thickness of metal plate by ultrasonic harmonic method. I. On the condition of the thickness resonance. S. TANAKA. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **2**, 917–24 (*Dec.*, 1950).

In the measurement of the thickness of metal plates by this method, it is usually considered that standing waves will be set up within a metal plate to be tested. In general, however, the resonance should be determined depending on the condition of the acoustic coupling between the quartz crystal and the metal plate. A theoretical demonstration of the coupling action due to an oil film between two plates is given. A.

534.13 : 531.717

3935. Measurement of the thickness of metal plate by ultrasonic harmonic method. II. Electronic operation and results of a field inspection. S. TANAKA. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **3**, 201–8 (*April*, 1951).

After giving some technical notes on the arrangements of the circuit, the construction of the apparatus is presented. The accuracy and possibility of the measurement are considered under various conditions of the metal plate to be tested. Accuracy figures are given for the case of a penstock wall thickness inspection. A.

534.13 : 531.717

3936. Measurement of the thickness of metal plate by ultrasonic harmonic method. III. On the resonance of lower harmonic order. S. TANAKA AND S. YAMADA. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **3**, 393–6 (*June*, 1951).

When the harmonic order of the thickness resonance is extremely low, such as fundamental or second, it is distinctly seen that the apparent velocity of sound computed from the ordinary relation for the resonance tends to increase somewhat. An interpretation applicable to the resonance of such a lower order is given by introducing the phase shift of a sound wave reflected internally within the metal plate, referring to the results experimentally obtained. A.

534.131 : 531.224

3937. Rayleigh's principle and Newton's *regula falsi*. F. H. VAN DEN DUNGEN. *Bull. Acad. Roy. Belgique Cl. Sci.*, **38**, *No.* 7, 695–704 (1952) *In French.*

Two approximate methods of determining the normal modes of flexural vibration of a beam, simply supported at its ends, are shown to be equivalent. The differential equations for displacement and bending moment are first integrated, with an arbitrarily chosen constant value for the frequency, so as to satisfy all the boundary conditions except the vanishing of one terminal bending moment; the latter condition is replaced by a boundary condition on the displacement gradient. One method then makes use of Rayleigh's principle, the other uses Newton's rule to determine the zeros of the terminal bending moment, regarded as a function of the frequency.

J. G. OLDROYD

534.141.4

3938. The mechanics of edge-tones. N. CURLE. *Proc. Roy. Soc. A*, **216**, 412–24 (*Feb.* 10, 1953).

By consideration of the frequency spectrum of the sound field of an oscillating linear jet, it is found that one may expect a continuous spectrum of frequencies from 0 to $0{\cdot}08U_0/d$, where U_0 = mean velocity of efflux of the jet, d = width of slit, the maximum amplitude occurring at the frequency $0{\cdot}055U_0/d$ which is found experimentally. To explain the tones produced when an edge is placed in such a flat jet, it is shown that the hydrodynamic effect of the edge is to amplify those oscillations of the jet which have a certain particular frequency in the band of frequencies to which the jet is unstable. This is due to the reciprocal influence of the maximum transverse velocity in the jet upon the shedding of vortices at the edge, and of the sudden production of free vorticity at the edge in deflecting the jet and so causing a slight extra production of vorticity on one side of the slit, which is in turn amplified as it moves downstream. From this one deduces that vortices of opposite circulation are produced simultaneously at the upper edges of the slit and the wedge, and similarly at the lower edges, and also that the jet wavelength λ and the edge to slit distance h are related by an equation $h = (i + \frac{1}{4})\lambda$, where i is an integer. It is suggested that the value of i is such that λ is near the jet-tone wavelength which gives maximum amplitude. Independently of this, an expression, partly theoretical and partly empirical, is obtained for the velocity with which the vortices move along. A formula for the edge-tone frequency is then deduced in the form $f = \frac{1}{2}U_0(i + \frac{1}{4}/h - 1/30d)$, where d = slit-width. This formula applies only when $h/d > 10$, i.e. when the edge to slit distance is at least 10 slit-widths. The predictions of the theory as regards the numerical values of the jumps in frequency, dependence of frequency upon slit-width, and absolute values of wavelength and frequency, are examined in the light of previous experimental results, and are found to be satisfactory. A.

534.152 : 621.395.623

3939. Electromechanical pick-up calibration by the interferometer method. C. A. ZIEGLER. *J. Acoust. Soc. Amer.*, **25**, 135–7 (*Jan.*, 1953).

For such calibration the pick-up output voltage, the vibration frequency, and the vibration amplitude must be determined. The last alone presents difficulties but it can be measured by means of a Michelson interferometer. The complete apparatus is made up of (*a*) an optical system consisting of the interferometer and a monochromatic light source, and (*b*) a vibrating system consisting of a piezo-electric exciter and two piezo-electric accelerometers, the former driving the pick-up under test at the desired frequencies. One of the returning mirrors of the interferometer is attached to the vibrating system, care being taken to ensure that its amplitude of vibration is the same as that of the pick-up. The fringe pattern intensity of the interferometer is related to the wavelength of the light and the amplitude of vibration of the mirror by an expression which involves a Bessel function term. At certain vibration amplitudes this term vanishes and accordingly the fringes vanish, too, leaving a uniformly illuminated field. Generally, 3 to 6 such points can be utilized at any one frequency, and accordingly not only can the vibration amplitude be determined accurately, but also the linearity of the pick-up response. Actual sensitivity *v.* frequency and output-voltage *v.* vibration-amplitude curves are shown. The overall error of the method is estimated as 5%. H. G. M. SPRATT (R)

534.21

3940. Transmission of ultrasonic waves through a plane plate made of viscoelastic material immersed in a liquid medium. Y. TORIKAI. *J. Phys. Soc. Japan*, **8**, 234–42 (*March–April*, 1953).

The absorptive properties of the solid medium which have been neglected in previous theory are considered. The resulting expression for the transmission is of the same form as in the case of a non-absorptive plate, but the propagation constants of the waves are replaced by complex quantities in the expression. It is shown that when the absorption by the plate is appreciable, the more simple formula can be applied and the formula agrees well with the experimental result. As a note on Srivastava's papers, it is explained that the velocity of rotational waves obtained from the apparent critical angle for rotational waves is always larger than the real value on account of the absorptive property of the solid medium. A.

534.211

3941. On sound waves of finite amplitude. E. T. COPSON. *Proc. Roy. Soc. A*, **216**, 539–47 (*Feb.* 24, 1953).

An analytical solution of Riemann's equations for the one-dimensional propagation of sound waves of finite amplitude in a gas obeying the adiabatic law $p = k\rho^\gamma$ is obtained for any value of the parameter γ. The solution is in the form of a complex integral involving an arbitrary function which is found from the initial conditions by solving a generalization of Abel's integral equation. The results are applied to the problem of the expansion of a gas cloud into a vacuum. A.

534.213.4

3942. Attenuation of sound in a tube. F. A. ANGONA. Letter in *J. Acoust. Soc. Amer.*, **25**, 336 (*March*, 1953).

An experimental method of measuring the attenuation of sound in a circular tube for gases at reduced

pressures has been developed. Since the tube effect is inversely proportional to the square root of the pressure, a reduction in pressure increases the attenuation and thus increases the experimental accuracy. The tube attenuation was measured for the frequency over pressure ratio of 8 to 2000 kc/s. atm.$^{-1}$. The measured attenuation was found to be 4·5% greater than that predicted by the Kirchhoff formula. A.

534.22

3943. On the speed of sound in gases. I. I. GLASS. *J. aeronaut. Sci.*, **19**, 286–7 (*April*, 1952).

Speed of sound in air, A, and CO_2 is determined by measuring speed of head of the rarefaction waves in a shock tube. Results are in good agreement with the values obtained from acoustic methods and from isentropic theory. Experimental arrangement and accuracy of method are briefly described.

APPLIED MECHANICS REVIEWS

534.22 : 532.7

3944. Dispersion of ultrasonic waves in esters. S. PARTHASARATHY, A. F. CHHAPGAR AND H. SINGH. Letter in *J. Acoust. Soc. Amer.*, **25**, 335 (*March*, 1953).

The light diffraction method is used in the endeavour to detect ultrasonic dispersion of a group of esters in the frequency range from 4·3 to 15·9 Mc/s. No measurable dispersion was detected. A.

534.222.2

3945. The shape and thickness of shock fronts in argon, hydrogen, nitrogen, and oxygen. E. F. GREENE AND D. F. HORNIG. *J. chem. Phys.*, **21**, 617–24 (*April*, 1953).

Measurements of shock front thicknesses in A by the reflectivity method have been extended to Mach 2.09, and the shape of the front has been investigated by comparing the experimental results with the reflectivity expected on the basis of five simple models for the density change through the front. The thicknesses agree with Zoller's calculations but for the strongest shocks are considerably greater than those of other theoretical estimates. The magnitude and form of the reflectivity (as a function of $\lambda/L\cos\theta$) of shock fronts in three diatomic gases have been used to study the rate of equilibration of rotational with translational energy. H requires more than one hundred and fifty collisions for this equilibration, while N and O equilibrate much more rapidly. For the latter two gases there is evidence that at least two relaxation times are involved in the equilibration. A.

534.222.2 : 536.45

3946. Luminosity generated by shock waves. R. N. HOLLYER, JR, A. C. HUNTING, O. LAPORTE AND E. B. TURNER. Letter in *Nature* [*London*] **171**, 395–6 (*Feb.* 28, 1953).

Describes certain phenomena, relating to the formation of luminosity, in shock tubes where, for example, the pulse is generated with a compression chamber pressure of 3 atm. H_2 and passes into Xe at 6–30 mm Hg. It is established that the luminosity generated behind shocks can be purely a temperature effect. Temperatures up to 18 000°K are calculated.

J. D. CRAGGS

534.23 : 539.32 : 532.12

Internal pressure. *See Abstr.* 3898

534.23

3947. Ultrasonic absorption and relaxation mechanism. A. K. DUTTA. *Indian J. Phys.*, **26**, 279–82 (*June*, 1952).

It is considered that absorption of elastic waves is always due to some sort of relaxation mechanism which may be of varied nature. The general relationship to express the coefficient of absorption may, however, be put in the same form for different types of relaxation mechanism, with two constants which are determinable by the process of relaxation mechanism. As such, the absorption due to viscosity considered by Stokes, is also regarded as arising from a relaxation mechanism termed frictional relaxation mechanism. On this basis the usual Stokes relation for absorption coefficient requires modification. From a systematic correlation between the discrepancy in experimental and calculated values of α/ν^2 on Stokes theory on the one hand and the broadening of elastic wave diffraction spectral lines on the other, for different liquids, it has been argued that the same relaxation mechanism should explain the discrepancy in different cases and this has been considered to be due to the necessary modification of the Stokes theory of absorption. Thus, it is considered that the absorption of elastic waves is mainly due to the frictional relaxation mechanism in different liquids. A.

534.23

3948. Equivalence of sonic and thermal energies. S. PARTHASARATHY, S. S. CHARI AND D. SRINIVASAN. Letter in *J. Acoust. Soc. Amer.*, **25**, 335–6 (*March*, 1953).

In the absorption of 4 Mc/s sound in liquids the complete conversion of sound energy into thermal energy is substantiated. A.

534.23 : 532.7

3949. Symposium on ultrasonic absorption in fluids at Brown University (October, 1952). R. B. LINDSAY. Letter in *J. Acoust. Soc. Amer.*, **25**, 337–8 (*March*, 1953).

A brief résumé of the papers presented and of the discussions that followed. T. C. TOYE

534.23 : 532.7

3950. Ultrasonic absorption in liquid mixtures and structural effects. D. SETTE. Letter in *J. chem. Phys.*, **21**, 558 (*March*, 1953).

The dependence of the absorption coefficient on temperature and on frequency for certain binary liquids near compositions corresponding to maximum absorption has been measured. The decrease of the maximum absorption coefficient with increases in both the above parameters is taken to indicate that the observed effects are structural in nature. Further work is proceeding and will be reported later.

T. C. TOYE

534.231 : 533.6.011

3951. Acoustical radiation from the velocity field in a compressible fluid. E. N. PARKER. *Phys. Rev.*, **90**, 240–2 (*April* 15, 1953).

The problem of computing the radiative portion of a field is considered. By considering the process of emitting radiation, an operational interpretation of the wave equation is developed. This interpretation allows one to write down immediately the inhomogeneous wave equation expressing the radiation from

a velocity field in a compressible medium. Guided by the concepts developed in the discussion of the emission of radiation, the inhomogeneous wave equation is deduced from the Navier–Stokes equations. This computation also yields the scattering of the radiative field by the non-radiative flow. A.

534.231 : 535.515

3952. Direct viewing of an ultrasonic beam in a transparent solid. F. L. McNAMARA AND T. F. ROGERS. Letter in *J. Acoust. Soc. Amer.*, **26**, 338–9 (*March*, 1953).

Temporary birefringence, induced by ultrasonic stress, causes a depolarization in a plane-polarized light beam traversing a transparent quartz plate. Detection of this depolarization allows the complete sound field to be made visible. Photographs taken by this technique are shown. A.

534.232

3953. Crystal acoustic arrays. W. WELKOWITZ. Letter in *J. Acoust. Soc. Amer.*, **25**, 336–7 (*March*, 1953).

A point source method for rapid design of a crystal transducer array using three crystal thicknesses in the ratio of 1 : 2 : 4 has been developed. Formulae are presented for main lobe width and ratio of secondary lobe amplitude to main lobe amplitude. For a 10×10 array (100 elements) this method of design leads to a relative side lobe level of 22 db as compared to a value for a uniform array of 13·4 db at the expense of having a beam width 1·25 times as wide as the uniform array. A.

534.24

3954. Comments on "A note on critical reflections of elastic waves at free surfaces." R. D. MINDLIN AND T. KANE; W. S. JARDETZKY. Letters in *J. appl. Phys.*, **24**, 498–9 (*April*, 1953).

Mindlin and Kane agree with the results found by Goodier and Bishop [Abstr. 2537 (1952)] which indicate that reflected plane waves at grazing incidence must contain a component whose amplitude near the surface increases linearly, to the first order, with departure from the surface, and this must apply to the infinite number of such waves. Jardetzky, however, maintains that artificial assumptions are made in obtaining the results, because the integrals used in the computations have to be taken in different forms for grazing and non-grazing incidence. H. J. H. STARKS

534.26

3955. The diffraction of sound pulses by an oscillating, infinitely long strip. F. J. BERRY. *Quart. J. Mech. appl. Math.*, **5**, 324–32 (*Sept.*, 1952).

The solution is given for the problem of a plane pressure pulse normally incident on an infinitely long strip of finite width, capable of motion as a spring-supported rigid body. Numerical results are given for a sharp-fronted pulse of constant pressure; graphs illustrate the way in which the mobility of the strip affects the pressure distribution on the back of it. A.

534.26

3956. The diffraction of a sound pulse by a non-rigid semi-infinite plane screen. F. J. BERRY. *Quart. J. Mech. appl. Math.*, **5**, 333–43 (*Sept.*, 1952).

A treatment of the two-dimensional diffraction of a plane-fronted pulse, normally incident on a screen, each particle of which is able to yield under the action of the incident pressure. Two methods are given for finding the pressure changes across the screen; each is approximate. Graphs illustrating the results are given for several types of screen material. A.

534.321.9 : 541.18.041

3957. On the emulsification of the flotation reagents by means of ultrasonic waves. T. ÔYAMA AND S. TANAKA. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **2**, 925–7 (*Dec.*, 1950).

The object is to obtain high selectivity for the differential flotation with the lowest economical consumption of the flotation reagents. By this process, the ore minerals to be required can be collected with high efficiency due to the increase of the floating action; even if the reagents hardly mix with water the emulsion can be readily intermixed into the pulp. A.

534.6

3958. The absolute calibration of sound receivers by the reciprocity method in a tube with standing waves. M. V. KAZANTSEVA. *Zh. tekh. Fiz.*, **21**, *No.* 10, 1213–23 (1951) *In Russian.*

In 1947 data on the calibration of receivers by this method was published for tubes of large diameter (at frequencies up to $1{\cdot}5 \times 10^3$ c/s). The present paper is concerned with the theory and results of the method in the case of small diameter tubes (freq. up to 10×10^3 c/s). F. K. CZARNIECKI

534.612 : 621.395.61

3959. An experimental probe microphone for the measurement of sound pressures. R. B. ARCHBOLD. *Post. Off. elect. Engrs' J.*, **45**, 145–8 (*Jan.*, 1953).

Such probes are used for testing telephone transmitters and receivers. They must not seriously disturb the sound field into which they are placed because of their size and must have a high acoustical impedance compared with that of the acoustical circuit they are measuring. The design described meets these requirements and covers a range of 80 c/s–8 kc/s. The microphone proper is of the moving-coil type and is housed in a heavy mild-steel case which provides magnetic screening. The probe consists of a 5 in. long stainless steel tube of 0·03 in. internal dia. with a rigid brass protecting cover which extends up to about the last 1 in. The bore of the tube leads into the centre of an enclosed cavity in front of the diaphragm. Sensitivity, and smoothness and range of frequency characteristic depend mainly upon the clearances in the cavity, both at the edges and the centre, and the results of slight changes in these dimensions are discussed at length. Other probe microphones with larger diameter probes and correspondingly higher sensitivity are briefly discussed. Damping by means of lambs' wool or glass wool can be introduced with advantage for smoothing the frequency characteristic. H. G. M. SPRATT (R)

534.7 : 612.85

Physiological acoustics. Hearing. *See Abstr.* 4533

534.833 : 534.861.1 : 621.396.712.3

3960. Resonator absorbers in broadcast studios. R. K. VEPA. *Indian J. Phys.*, **26**, 126–41 (*March*, 1953).

L.F. absorption is often a matter of great difficulty

in broadcast studios and different methods of providing it are discussed. It is shown that a perforated rigid sheet held at some distance from a non-yielding backing offers a convenient means of l.f. absorption and expressions for the resonance frequency absorption coefficient, and Q value in terms of the physical parameters are derived. An experimental method is described both for the case of normal incidence (tube experiment) and random incidence (reverberation chamber). The effects of coupling and artificial damping of such structures are also studied. Finally some considerations for practical designs are outlined. A.

OPTICS RADIATION . SPECTRA 535

535.1 : 519.2

3961. Optics and the theory of stochastic processes. N. Wiener. *J. Opt. Soc. Amer.*, **43**, 225–8 (*April*, 1953).

The study of the wave phenomena of physical optics and of quantum mechanics must take into account the fact that experimental instruments operate linearly on the field quantities, while all measured values depend only on their mean squares. The latter circumstance necessitates a statistical approach to these theories. Certain questions must be re-examined in the light of this fact. The most important of these, namely that of the limitations causality (the directedness of time in physical phenomena) imposes on the nature of the transformations an optical instrument can perform on the light admitted to it, is analysed. A.

535.1 : 519.2

3962. Optics and communication theory. P. Elias. *J. Opt. Soc. Amer.*, **43**, 229–32 (*April*, 1953).

Illustrates the application of some mathematical techniques originally developed for the analysis of electric networks and other communications problems. Two general aspects of communication theory may be so applied. The first is electrical network theory. This may be further subdivided. First there is the standard treatment of the response of networks to individual signals by means of Fourier analysis. The optical analogue of this is the analysis of images, also by Fourier transform techniques. Second, there is the statistical network theory initiated by N. Wiener and developed by Y. W. Lee. One aspect of this theory is the design of optimum linear systems for separating a signal from a noise. This is relevant to the problem of the removal of grain from photographs. The second aspect of communication theory which is relevant in optics is the general statistical information theory of Shannon and Wiener. This is especially valuable in the analysis of scanning systems treating signals and noise. The autocorrelation function of a picture is useful in both kinds of analysis, and will be discussed. A.

535.241.3

3963. The primary standard of luminous intensity and the photometric scale at the Conservatoire National des Arts et Métiers. M. Debure and N. Leroy. *Rev. Opt.*, **31**, 529–44 (*Dec.*, 1952) *In French.*

The setting up of a new photometric scale has first required the realization of the primary standard of light in the form of a Planckian radiator (black body) at the temperature of solidification of molten platinum. Though any particular form of Planckian radiator is not specified by the International Committee, the specifications described by the N.B.S. in the reports of the C.I.P.M. (1931) have been adhered to by using a fused thoria crucible. The luminance of the full radiator, determined as a function of international candle, has been found equal to 58·82 candles per cm^2. The maintenance of the photometric units (luminous intensity and luminous prescribed) by means of substandard lamps operating at the flux colour temperatures is also described. A.

535.241.3 : 535.65

3964. Attempts to construct a standard white light source for colorimetry. I. Leucoscope. F. Blottiau and H. Royer. *Rev. Opt.*, **32**, 91–103 (*Feb.*, 1953) *In French.*

A filter is required with a total transmitting power as high as possible and which, with an incandescent lamp of 2850°K colour temperature, could give a distribution of light in the visible spectrum near the distribution of light of black body at 5000°K. It is shown that simple and double leucoscopes cannot be used. The theory of an "elliptic light leucoscope" formed with a quartz plate cut perpendicular to the optical axis, between 2 quarter-wave plates placed between 2 polarizers. A.

535.313 : 612.841

3965. Optical method of studying the shape of a reflecting surface. J. Lenoble. *Rev. Opt.*, **31**, 393–9 (*Aug.–Sept.*, 1952) *In French.*

A method of measuring the shape of reflecting surfaces, applicable to the cornea of the eye, is studied. The method consists of photographing the images of several points of light, reflected by the surface, and deducing the meridian line of the surface from the positions of these images on the photographic plate. A.

535.315 : 535.345

3966. Effect of absorption by the material of the prism on its resolving power. M. S. Sodha. *Amer. J. Phys.*, **21**, 313 (*April*, 1953).

The resolving power is determined by the Rayleigh criterion as a function of the absorption. An approximate method is given for cases of practical importance when the absorption is small. The resolving power is found to decrease slowly with increasing absorption. R. W. FISH

535.317

3967. Utilization of the results of ray trace calculations in an optical system. G. Toraldo Di Francia. *Rev. Opt.*, **31**, 381–92 (*Aug.–Sept.*, 1952) *In French.*

Simple formulae are given for calculating the coma and the variations of the spherical aberration and the astigmatism using the results obtained from ray traces. Numerous examples show that these formulae yield, in most cases, a good approximation to these aberrations, contrary to the third-order theory. A.

535.317

3968. Remarks on the differential laws of image deformation. P. M. Duffieux. *Rev. Opt.*, **31**, 485–90 (*Nov.*, 1952) *In French.*

Most conditions of good image quality are based on integrals of the proximity between the emergent wave

from the optical instrument and a portion of a sphere. Some examples, taken particularly from gratings, show that images can be good although the proximity integrals exceed the usually admitted limits. The true criterion of the quality of an image is its likeness to the object or a pattern suggesting the object. It seems that it is easier to define it in terms of the transmission functions of the image, either in amplitude or in energy. A.

535.317.4

3969. Aberration of decentred optical systems. M. KIUTI. *Sci. Pap. Coll. Gen. Educ. Univ. Tokyo*, **1**, 19–36 (*Oct.*, 1951).

Complete formulae are given expressing the 3rd order image defects of an optical system which consists of imperfectly centred spherical refracting surfaces. The modifications to the Seidel aberrations resulting from decentring are determined. R. W. FISH

535.322.4

3970. A precision refractometer without circular scale. A. C. S. VAN HEEL. *Appl. sci. Res. B*, **2**, *No.* 6, 467–77 (1952).

Determination of the refractive index of liquids and solids by means of the measurement of the critical angle can be performed without a divided circle when the refractometer prism is provided with permanent standard samples and the pencils produced by it are each split up by a fourfold mirror into four pencils before reaching the (apochromatic) objective lens of the observing fixed telescope. The measurement consists in determining the distance in the focal plane of the objective lens between one of the four border lines produced by the sample and a line produced by one of the standard samples. This measurement is performed by means of an eyepiece, fitted with cross-wires and mounted on a sliding carrier with screw and divided drum. The range is 25 mm, the precision of pointing need not be better than 0·01 mm. The whole range of refractive indices 1·31 to 1·7 can be measured with one prism block. The precision with which the refractive index is found is about 0·00001. The prism block and the compound of mirrors is not cemented, but the parts are wrung together without interposition of any intermediate substance. Even with the different glasses of the prism block this proved to be a permanent and solid contact. Thus the possibility of changes in the constants of the apparatus is obviated. A.

535.322.4

3971. Fiduciary fringes in the Jamin refractometer. P. G. GUEST AND W. M. SIMMONS. Letter in *J. Opt. Soc. Amer.*, **43**, 319 (*April*, 1953).

In a Jamin refractometer, the fringes are normally set against a crosswire and inaccuracies may result if there is a slow drift with temperature changes. A simple method of obtaining a set of comparison fringes is described. Results suggest that, with this system, an observer can consistently set to better than 1/80th of a fringe. R. W. FISH

535.322.4

3972. A phase contrast refractometer with high accuracy for gases and liquids. E. INGELSTAM. *Ark. Fys.*, **6**, *Paper* 26, 287–316 (1953).

The refractometer uses a photoelectric device to obtain accuracies of the order of 1/1000th wavelength, corresponding to a refractive index accuracy of $0{\cdot}04\times10^{-6}$. A large working range is obtained by combining the instrument with a Young double slit arrangement, which provides a coarse scale for the whole wavelengths included in the optical path difference measured. The theory is given and the application to measurements on oxygen discussed.

R. W. FISH

535.323

3973. The dispersion formulae of solids. T. RADHAKRISHNAN AND G. N. RAMACHANDRAN. *Rev. Opt.*, **32**, 65–72 (*Feb.*, 1953) *In French.*

It is shown that the experimental data on the refraction and absorption of crystals are better explained by the Sellmeier–Drude than by the Lorentz–Lorenz dispersion formula. A.

535.33

3974. Resolution of two spectral lines of unequal intensity. M. S. SODHA. Letter in *Sci. and Culture*, **18**, 248–9 (*Nov.*, 1952).

The minimum intensity of the resultant pattern with equal spectral lines is $8/\pi^2$ times that of either maximum. The suggested criterion for unequal lines is that the minimum between the lines should have an intensity $8/\pi^2$ times the lower maximum. The resolution is found as a function of the ratio of the line intensities. R. W. FISH

535.33.03

3975. Short period investigations in spark discharges. D. W. STEINHAUS, H. M. CROSSWHITE AND G. H. DIEKE. *J. Opt. Soc. Amer.*, **43**, 257–70 (*April*, 1953).

With the help of an automatic electronic switch placed between phototube and recorder of a spectrograph, the intensities as function of time of a series of spectrum lines produced in a spark have been recorded. The changes as function of the position in the gap were also investigated. There is an extensive afterglow which in general decays faster for the higher stages of ionization. The continuous background has the same characteristics as the spectrum of the surrounding gas. The changes in self-absorption excitation and line profile were also studied as function of time and partly correlated with the fundamental processes responsible for the afterglow. A.

535.33.07

3976. A spectrometer for measuring relative intensities with the alternating light method. J. M. W. MILATZ, F. BOESCHOTEN AND J. A. SMIT. Letter in *Physica*, **18**, 646 (*Aug.–Sept.*, 1952).

Outlines the principles and performance of a 2-beam null instrument using a single photocell.

G. F. LOTHIAN

535.33.07

3977. A simple variable thickness cell for liquids. A. V. STUART. Letter in *J. Opt. Soc. Amer.*, **43**, 212–13 (*March*, 1953).

A cell with NaCl windows and 1 mm range of thickness. G. F. LOTHIAN

535.33.07

3978. Optical design of double-beam spectrometers. E. F. DALY. Letter in *Nature* [*London*] **171**, 560–2 (*March* 28, 1953).

Two fundamental conditions are given relating to the light distributions in the two beams of a fast

scanning double-beam spectrometer. The application of these conditions to an i.r. spectrometer is described in detail. R. W. FISH

535.33.07 : 535.339

3979. Design of double-beam multiple monochromators. A. WALSH. Letter in *J. Opt. Soc. Amer.*, **43**, 215 (*March*, 1953).

The ratio recording system of Savitzky and Halford [Abstr. 5681 (1950)] may be modified for use with such instruments. G. F. LOTHIAN

535.33.07 : 535.345.6

3980. Filter spectroscopy. O. MACEK. *Arch. tech. Messen, Issue* 201 (*Ref. J*384–1) 235–8 (*Oct.*, 1952) *In German.*

A review of the spectral properties of photocells and filters, including interference filters, for use in these instruments. G. F. LOTHIAN

535.33.07 : 535.421

3981. Construction of a diffraction grating spectrograph. R. L. PURBRICK. *Amer. J. Phys.*, **21**, 241–3 (*April*, 1953).

The construction and operation of a simple Wadsworth-mounted 21 ft 10 in. diffraction grating spectrograph is described. The instrument covers the range from 9000 Å to 1800 Å in the first order with a linear dispersion of 5 Å/mm. A.

535.33.07–15

3982. Infrared spectrometry with a cesium iodide prism. E. K. PLYLER AND N. ACQUISTA. Letter in *J. Opt. Soc. Amer.*, **43**, 212 (*March*, 1953).

Measurements on CBr_2Cl_2, $CHBrCl_2$ and $CHBr_3$ have been made up to $\lambda = 52\,\mu$. Cell window materials and methods of removing scattered radiation are considered. G. F. LOTHIAN

535.33.07–15

3983. Interferometric wavelength measurements in the near infrared. D. H. RANK, J. M. BENNETT AND T. A. WIGGINS. Letter in *J. Opt. Soc. Amer.*, **43**, 213–14 (*March*, 1953).

An etalon with glass plates whose reflection is increased by $\lambda/4$ coatings of ZnS is used with white light. A precision of $0{\cdot}03\ cm^{-1}$ is obtained, which is checked by measurements on a CH_4 band.

G. F. LOTHIAN

535.33.07–15

3984. High resolution spectroscopy in the infrared. D. H. RANK, E. R. SHULL AND T. A. WIGGINS. Letter in *J. Opt. Soc. Amer.*, **43**, 214–15 (*March*, 1953).

A blazed grating of 120 000 lines is used in a double pass arrangement [Abstr. 1491 (1953)] with a resolution of $0{\cdot}05\ cm^{-1}$ at $6000\ cm^{-1}$. Pressure broadening of a CH_4 band is investigated. G. F. LOTHIAN

535.338

3985. Effect of spectral line shape on apparent rotational temperatures of OH. S. S. PENNER. *J. chem. Phys.*, **21**, 686–8 (*April*, 1953).

The effect of spectral line shape on apparent rotational temperatures of OH has been investigated for the P_1 branch, $^2\Sigma \rightarrow {}^2\Pi$ transitions, (0, 0) band, by treating the ratio of collision half-width to Doppler half-width as a variable parameter. The results of calculations for emission experiments, using conventional plots, show a large effect of line shape on apparent temperature. In general, the greater the ratio of collision half-width to Doppler half-width, the smaller the distortion of experimental data. The analysis predicts higher apparent rotational temperatures for isothermal systems at reduced pressures than at atmospheric pressures. Although this result is in agreement with experimental observations on flames, it cannot be used as an explanation for the observed data without auxiliary studies proving that distortion of data is of importance in any given case. The two-path method for determining temperatures and emissivities (concentrations) in flames has been extended to spectral lines with combined Doppler- and collision-broadening. A.

535.338 : 538.615

3986. The Zeeman effect in the spectra of tellurium. J. B. GREEN AND R. A. LORING. *Phys. Rev.*, **90**, 80–3 (*April* 1, 1953).

Over one hundred lines of tellurium have been investigated in fields of approximately 36 000 gauss; g values have been established for Te I, Te II, Te III, and from one line of Te IV. Classifications already published for many of these lines are in general agreement with the Zeeman patterns given in this report. Some previously indefinite assignments of j values are established. A.

535.338.3

3987. Determination of absolute f values from relative intensity measurements for spectral lines with Doppler contour. S. S. PENNER. Letter in *J. Opt. Soc. Amer.*, **43**, 218–19 (*March*, 1953).

It is suggested that it should be possible to determine absolute f values by combining relative intensities of emission lines with the results of 2-path experiments. The necessary mathematical relationships are given.

A. G. GAYDON

535.338.332

3988. Hyperfine structure of the spectrum of tungsten. K. MURAKAWA. *J. Phys. Soc. Japan*, **8**, 215–18 (*March–April*, 1953).

The hyperfine structure of the W I spectrum was studied, and the ratio of the distances of the neighbouring components corresponding to the even isotopes $\Delta(184–182)/\Delta(186–184)$ was determined to be $1{\cdot}206 \pm 0{\cdot}010$. Isotope displacement effect in 55 lines of W I and the relative isotope displacement effect in about 29 terms of W I are tabulated. Some odd levels are interpreted as arising from the electron configuration $5d^36s^26p$. A.

535.338.332 : 539.153

New fine structure in neutral oxygen. *See Abstr.* 4294

535.338.333

3989. Hyperfine structure of the spectrum of Mg I. K. MURAKAWA. *J. Phys. Soc. Japan*, **8**, 213–14 (*March–April*, 1953).

Isotope shift ($Mg^{26}–Mg^{24}$) in the lines Mg I λ4571 ($3^1S_0–3^3P_1$) and λ2852 ($3^1S_0–3^1P_1$) was measured. Terms of Mg I isotope shifts that have been measured by various authors are summarized in a diagram. A.

535.338.333

3990. Isotope shift in the plutonium spectrum. J. G. CONWAY AND M. FRED. Letter in *J. Opt. Soc. Amer.*, **43**, 216 (*March*, 1953).

A 30 ft grating spectrograph was used. Splittings between Pu^{238} and Pu^{242} are listed for 27 lines, and between Pu^{239} and Pu^{240} for 4 lines. The full pattern is shown for the line 4021 Å. A. G. GAYDON

535.338.4

3991. The emission bands of aniline. R. K. ASUNDI AND B. N. BHATTACHARYA, JR. Letter in *Curr. Sci.*, **25**, 308 (*Nov.*, 1952).

Emission bands corresponding to the 2600 Å absorption bands of aniline have been observed by r.f. discharge in flowing aniline vapour. The emission lies at longer wavelengths than absorption, the bands becoming more closely packed with wavelength increase. G. F. J. GARLICK

535.338.4 : 538.343.4

3992. Atlas of characteristic wavelengths of emission and absorption bands of diatomic molecules [Atlas des longueurs d'onde caractéristiques des bandes d'emission et d'absorption des molécules diatomique]. R. F. BARROW, A. D. CAUNT, A. R. DOWNIE, R. HERMAN, E. HULDT, A. MCKELLAR, E. MIESCHER, B. ROSEN AND K. WIELAND. *Paris: Hermann et Cie* (1952) 389 *pp.* [Tables de constantes et données numériques. Constantes selectionnées, 5.] *In French.*

1. About 13 000 band heads or band maxima of nearly 300 diatomic molecules arranged in order of decreasing wavelengths between 15 000 and 750 Å. 2. About 4000 individual lines of H_2 in the same region. 3. Separate lists containing about 2500 band heads of C_2, CH, CH^+, CN, CO, CO^+, N_2, N_2^+. NH, NH^+, NO, O_2, O_2^+, OH, OH^+, arranged for each of the molecules in order of decreasing wavelengths.

535.338.4–15 : 523.87

3993. A new infra-red band system of FeO. A. M. BASS AND W. S. BENEDICT. Note in *Astrophys. J.*, **116**, 652–3 (*Nov.*, 1952).

The vibrational analysis of a system excited in a CO-flame containing $Fe(CO)_5$ is reported. The following constants are derived: $\nu_{0,0} = 10\,332$, $\omega' \sim 651$, $\omega'' \sim 864\ cm^{-1}$. R. F. BARROW

535.338.4–32

3994. On the Miescher–Baer emission bands in the far ultraviolet region. Y. TANAKA. Letter in *J. chem. Phys.*, **21**, 562–3 (*March*, 1953).

The system [see Abstr. 4236 (1952)] has been considerably extended to shorter wavelengths. It is excited most readily in an uncondensed discharge through He + NO. It is suggested that the system is $^1\Pi - X^1\Sigma^+$ of NO^+. R. F. BARROW

535.338.42 : 539.132 : 523.87

3995. The vibration spectrum of $N^{14}N^{15}$. D. R. BATES. Note in *Astrophys. J.*, **117**, 236–7 (*Jan.*, 1953).

The oscillator strength for the fundamental band at 2331 cm^{-1} is calculated to be $2{\cdot}4\times10^{-14}$, about 10^3 times smaller than that for the fundamental of H^1H^2. R. F. BARROW

535.343–14

3996. The possible microwave absorption in the molecules belonging to the point groups $D_{2d} \equiv V_d$ and T_d. M. MIZUSHIMA AND P. VENKATESWARLU. *J. chem. Phys.*, **21**, 705–9 (*April*, 1953).

It is shown that pure rotational absorption in the molecules belonging to the point group $D_{2d} \equiv V_d$ is possible if the molecule is in the excited, preferably lowest, doubly degenerate vibrational state. The approximate positions of these microwave absorption lines, as calculated from the B value obtained from the infrared data, are given in the case of allene. It is also shown that the pure rotational absorption is possible in the molecules belonging to the point group T_d if they are in the excited triply degenerate (F_2) vibrational states. The matrix element of dipole moment corresponding to the transition is about the same as that of the overtone vibrational bands, in both cases. A.

535.343–14 : 518.5

3997. Applications of large digital computers to calculations of microwave spectroscopy. B. L. HICKS, T. E. TURNER AND W. W. WIDULE. Letter in *J. chem. Phys.*, **21**, 564 (*March*, 1953).

Outline of programmes for asymmetric rotor eigenvalues, transformation matrices, and for deriving rotational constants from structural parameters.

D. H. WHIFFEN

535.343–14 : 538.615

3998. Zeeman effect in rotational spectra of asymmetric-rotor molecules. B. F. BURKE AND M. W. P. STRANDBERG. *Phys. Rev.*, **90**, 303–8 (*April* 15, 1953).

The theory of rotational molecular magnetic moments is applied to the study of the Zeeman effect in microwave rotational spectra of asymmetric-rotor molecules. Measurements on absorption lines of H_2O, D_2O and HDO are used to verify the theory, and the gyromagnetic tensors associated with these molecules are deduced. A discussion of electronic perturbation of rotational energy levels is appended. A.

535.343–15

3999. Infrared intensity measurements on nitric oxide, hydrogen chloride, and hydrogen bromide. S. S. PENNER AND D. WEBER. *J. chem. Phys.*, **21**, 649–54 (*April*, 1953).

The results of absolute infrared intensity measurements are described for the fundamentals and first overtones of NO, HCl and HBr. The new data are used to estimate the dependence of electric moment on internuclear distance. A.

535.343–15

4000. Some absorption bands in the far infrared. J. K. O'LOANE. Letter in *J. chem. Phys.*, **21**, 669–74 (*April*, 1953).

The following have been located in the far infrared spectra [illegible] NaCl [illegible] method of residual rays: *cis*-dichloroethylene at 170 cm^{-1}; *trans*-dichloroethylene at 265 cm^{-1} and 192 cm^{-1}; phosphorus trichloride at 190 cm^{-1}; *trans* and "*gauche*" 1,2 dichloroethane at 223 cm^{-1} and 125 cm^{-1}; propylene at 177 cm^{-1}; acetaldehyde at 245 cm^{-1} and 120 cm^{-1}; methyl alcohol at 190 cm^{-1}, 161 cm^{-1} and 120 cm^{-1}; carbon suboxide at 192 cm^{-1}. A.

535.343–31

4001. Ultra-violet bands associated with germanium. R. F. Barrow, G. Drummond and W. R. S. Garton. Letter in *Proc. Phys. Soc.* [*London*] *A*, **66**, 191–2 (*Feb.*, 1953).

Red-degraded absorption bands, of which the strongest are at 2454·2, 2464·0, 2510·5 and 2519·0 Å, appear in absorption through Ge vapour in presence of H_2 at about 1800°C. They may arise from GeH.

R. F. BARROW

535.343–31

4002. Classification and assignments of ultraviolet spectra of conjugated organic molecules. J. R. Platt. *J. Opt. Soc. Amer.*, **43**, 252–7 (*April*, 1953).

Empirical tests are accumulating by which the electronic states of conjugated organic molecules may be identified as to spin, parity, electron-excitation-type, and momentum or angular-momentum. The identifications are made as for atomic spectra, by finding Rydberg series in some cases, but more generally by examining the selection rules and the effects of perturbations. The observed intensities and transition times vary over a factor of 10^{10}, so that a superposition of selection rules giving several different degrees of forbiddenness must be recognized. The perturbations used are not the classical electric or magnetic fields. They are instead the strong local disturbances produced by polar solvent interactions; the spectral changes on chemical substitution and the changes produced in going to the next molecule of a homologous chemical series may also be treated in some degree as perturbations. The theory behind these methods of making assignments, just as in atomic spectra, is based only on general quantum-mechanical principles. Consequently the identifications of electronic states obtained by these methods are regarded as more certain than identifications based on detailed theoretical predictions of the energies or intensities which must assume the accuracy of particular atomic or molecular approximations. A list is given of the identifying characteristics of several different types of transitions, and examples of some types are shown. In a few molecules, complete assignments for six or more of the lower excited states are available. A.

535.343.1

4003. Resonance radiation from hydrogen flames containing alkali metals. C. G. James and T. M. Sugden. *Nature* [*London*] **171**, 428–9 (*March* 7, 1953).

Plots of the total absorption *v.* concentration for various alkali metals in H_2-air flames do not coincide at low conc. as theory requires. This is ascribed to the presence of stable hydroxide molecules in the flame. After correction to allow for this, the curves may be used to derive the collision diameters of the metal atoms, and results of the correct order are thus obtained, except for Cs. S. T. HENDERSON

535.343.2

4004. Analysis of the spectrum of the Nd^{+++} ion in the bromate crystal. R. A. Satten. *J. chem. Phys.*, **21**, 637–49 (*April*, 1953).

The absorption spectrum of single crystals of $Nd(BrO_3)_3.9H_2O$ was photographed in the visible and near infrared and ultraviolet in σ and π polarizations. Empirical energy level diagrams are presented for some of the groups of lines, and in this way it is found that the $^4I_{9/2}$ ground state is split in the electric field into five levels at 0, 115, 184, 363 and 382 cm^{-1}. An analysis is made of the spectrum based on a Russell–Saunders coupling model and a knowledge of the expected splitting of the levels of the free Nd^{+++} ion in the electric field of the crystal. The electrostatic interaction energies of terms arising from f^3 electrons were computed by the Slater method and the results agree with those previously given by Racah. The Landé interval factors were also computed in order to predict the multiplet splitting. Trial values of the parameters were first found by extrapolation mainly from Pr^{+++}. Selection rules for transitions in an electric field of C_{3v} symmetry are presented, and the results applied to the neodymium bromate spectrum indicate that the transitions are not purely electric dipole, quadrupole or magnetic dipole alone. A.

535.343.2–14

4005. Nuclear quadrupole resonance in some metal chlorides and oxychlorides. H. G. Dehmelt. Letter in *J. chem. Phys.*, **21**, 380 (*Feb.*, 1953).

535.343.2–15

4006. The infrared spectra of three solid phases of methyl ammonium chloride. R. D. Waldron. *J. chem. Phys.*, **21**, 734–41 (*April*, 1953).

Infrared spectra are presented for three crystalline phases of methyl ammonium chloride which occur at different temperatures. The spectrum of the high temperature structure reveals apparently degenerate vibrational frequencies for the perpendicular bands indicating little or no distortion from a threefold symmetry axis for the methyl ammonium ion. The intermediate and low temperature structures show increasing distortion of the cation as evidenced by increasing splitting of the degenerate absorption bands amounting to about 10–40 cm^{-1} in the low temperature form, where the torsional vibration about the C–N axis becomes infrared active. An assignment of frequencies is made in satisfactory agreement with a valence-force normal co-ordinate treatment and the isotope product rule. A simplified calculation of the height of the potential barrier to internal rotation was made yielding the approximate value, $V_0 = 1670\ cm^{-1}$. A.

535.343.2–15

4007. The infrared absorption characteristics of thermiated germanium. D. H. Rank and D. C. Cronemeyer. *Phys. Rev.*, **90**, 202–3 (*April* 15, 1953).

The i.r. absorption spectrum of thermiated Ge has been obtained. It is shown that this material in addition to its greatly changed electrical properties becomes strongly absorbing in the i.r. A 48 hr anneal in air at 500°C restores the infrared transmission to that identical with the untreated control sample. The absorption spectrum for chemically *P*-doped Ge has been obtained and the absorption cross-section for the *P*-doped material compared with that of thermium. A.

535.343.2–31

4008. Absorption band-systems of SiO and GeO in the Schumann region. H. C. Rowlinson and R. F. Barrow. Letter in *J. chem. Phys.*, **21**, 378–9 (*Feb.*, 1953).

The region 1250–2000 Å is being investigated: the

analysis of two systems of red degraded bands has been completed. The constants for these states are tabulated for both molecules. From comparison with spectra of other molecules limits of dissociation energy are obtained (8·0 eV for SiO and 6·8 eV for GeO). These values agree well with thermochemical data.

A. J. TAYLOR

535.343.2–31

4009. Ultraviolet absorption spectra of glasses containing Ti, and heavy metals. K. OSADA. *J. Phys. Soc. Japan*, **8**, 226–8 (*March–April*, 1953).

The characteristic u.v. absorption spectra of glasses with simple compositions were measured to 180 mμ with a small quartz spectrograph. The following results were obtained:

	Ti glass	Tl glass	Pg glass	Bi glass
absorption edge (mμ)	240	290	260	290
absorption maximum (mμ)	—	250	237	250

To investigate, particularly, the mechanism of the absorption maximum at 237 mμ of the Pb glass, spectra of acetate and of plumbite solution were measured. From the evidence that the spectrum of a mixed solution of Na and Pb acetate coincides with that of the Pb glass, it may be assumed that the appearance of the absorption maximum of the Pb glass is due to Pb ions bonded weakly to unsaturated oxygens in the network of SiO_4. The variation of luminescence efficiency with wavelength of exciting radiations was also measured within the range between 200 ~ 300 mμ, and it was found that the luminescence maximum appeared near the wavelength corresponding to the absorption maximum.

A.

535.343.3/.4–31

4010. Spectra of *p*-fluorobenzonitrile in the near ultraviolet. C. D. COOPER. Letter in *J. chem. Phys.*, **21**, 379–80 (*Feb.*, 1953).

Solution and vapour absorption spectra of 1, $4FC_6H_4CN$ were obtained between 3100 and 2200 Å. A strong and a weak region of absorption were observed. The weak region involved the transition A_1–B_1. If ortho-para or meta directing properties of the substituents are accounted for, the predicted value for ε_{max} does not agree well with the experimental value. Comparison with other spectra suggests that the spectral shift produced by a para fluorine atom depends upon the directing power of the other substituent. Broad diffuse bands are found in the strong region to which an A_1–A_1 transition is assigned.

A. J. TAYLOR

535.343.4

4011. The blue bands of benzaldehyde. R. K. ASUNDI, B. BHATTACHARYA AND N. APPALANARASIMHAM. Letter in *Curr. Sci.*, **21**, 273–5 (*Oct.*, 1952).

The spectrum was obtained of flowing benzaldehyde vapour on which a transformer discharge was applied. Most bands were broad and diffuse. A few narrow bands at the long wavelength side seemed by their structure to belong to a different emitter, possibly CN. Three systems of bands were indicated, each involving a ~1740 cm^{-1} frequency, which is close to one of the fundamental infrared vibrations of benzaldehyde. The frequencies found are tabulated.

A. J. TAYLOR

535.343

4012. Temperature dependence of the naphthalene bands at 3200–2900 Å. R. H. KNIPE, H. SPONER AND C. D. COOPER. Letter in *J. chem. Phys.*, **21**, 376–(*Feb.*, 1953).

As there existed uncertainty about the assignment for the 31 513 cm^{-1} and 32 754 cm^{-1} bands, spectra were taken in two ways: first the temperature was varied while the number of molecules was kept constant, and secondly the number of molecules was changed at constant temperature. The results suggest the existence of an energy difference between the ground states of the two bands. This conforms to the assignment of a forbidden transition.

A. J. TAYLOR

535.343.4

4013. The absorption spectra of free radicals formed in an electric discharge. P. J. DYNE. Note in *Canad. J. Phys.*, **31**, 453–5 (*March*, 1953).

Absorption spectra of the radicals OH, SH, CS, CN and NH_2 have been observed, using a radio frequency discharge, and a background illumination obtained with a flash tube. The discharge tube was 1·2 m long and the absorption spectra were taken with a simple mirror system and a Hilger E1 spectrograph.

J. D. CRAGGS

535.343.4

4014. Photoelectric absorption in lithium vapour. J. TUNSTEAD. Note in *Proc. Phys. Soc.* [*London*] *A*, **66**, 304 (*March*, 1953).

Measurements of continuous absorption of Li and Li_2 give values for the absorption cross-section and λ_{max}, near the series limit; comparison with calculated values is made.

G. F. LOTHIAN

535.343.4–14

4015. The microwave spectrum and general properties of ethyleneimine. W. S. WILCOX, K. C. BRANNOCK, W. DEMORE AND J. H. GOLDSTEIN. Letter in *J. chem. Phys.*, **21**, 563–4 (*March*, 1953).

Assignment [in agreement with abstract following] of observed transitions. Relative intensities show imine H atom not in C_2N plane.

D. H. WHIFFEN

535.343.4–14

4016. Preliminary analysis of the microwave spectrum of ethyleneimine. T. E. TURNER, V. C. FIORA, W. M. KENDRICK AND B. L. HICKS. Letter in *J. chem. Phys.*, **21**, 564–5 (*March*, 1953).

Observed transitions are assigned and a tentative structure given. The imine H atom is not in the C_2N plane [see also preceding abstract].

D. H. WHIFFEN

535.343.4–14 : 538.561

4017. Molecular spectroscopy with a Hertzian oscillator source of millimeter waves. A. H. NETHERCOT, JR. *Univ. Microfilms Publ. No.* 2629 (1951) 93 *pp.* (Photo-reproduction).

Abstract in *Microfilm Abstracts*, **11**, No. 3, 711–12 (1951). [The source consisted of small charged spheres of mercury (one thousand per second) falling freely to discharge by spark to an earthed mercury surface. Energy >0·1 μW between 11 and 2·5 mm. The rotational spectrum of CH_3Cl between 4·4 and 2·6 mm was observed.]

535.343.4–15

4018. A spectrometer for the far infrared and the spectrum of 1,2 dichloroethane. C. R. Bohn, N. K. Freeman, W. D. Gwinn, J. L. Hollenberg and K. S. Pitzer. *J. chem. Phys.*, **21**, 719–22 (*April*, 1953).

A brief description is given of a grating spectrometer which has been used in the wavelength range 22 to 77 microns. Test measurements of the pure rotation spectrum of water vapour gave excellent agreement with other investigators. The spectrum of 1,2 dichloroethane shows bands at 409, approximately 265, and 222 cm^{-1}. A band with its centre a little less than 135 cm^{-1} also is indicated. The value 223 cm^{-1} suggested for the antisymmetric skeletal deformation frequency of the *trans* form of dichloroethane by Mizushima, Morino and Simanouti is thus confirmed. Their suggestion was based on a very weak Raman band which they attributed to this infrared active frequency on the basis of a breakdown of selection rules in the liquid. Various statistical-thermodynamic calculations for this substance are also confirmed. A.

535.343.4–15 : 539.13

4019. The ozone band at 1110 cm^{-1}. J. N. Howard and J. H. Shaw. Letter in *J. chem. Phys.*, **21**, 558–9 (*March*, 1953).

Coriolis perturbations of ν_3 at 1040 cm^{-1} are consistent with a ν_1 fundamental at 1110 cm^{-1} and the obtuse angled model. D. H. WHIFFEN

535.343.4–31

4020. Absorption spectrum of *p*-chlorotoluene. G. Viswanath. *Indian J. Phys.*, **26**, 263–8 (*June*, 1952).

The u.v. absorption spectrum of *p*-chlorotoluene vapour has been photographed in the region 2818–2436 Å. An interpretation for most of the observed band heads has been suggested. Excited state frequencies 796, 1044, 1068 and 1189 cm^{-1} and difference frequencies 26, 57 and 100 cm^{-1} have been proposed. A comparison of ground state frequencies with those of Raman shifts has also been made. A.

535.343.4–31

4021. On continuous absorption in near ultra-violet spectrum of toluene at high temperatures. S. N. Garg. Letter in *J. sci. industr. Res.*, **11B**, 447–9 (*Oct.*, 1952).

A continuum, superposed on the 2600 Å band system, strengthens more rapidly with temperature than would be expected for a temperature collision phenomenon. The continuum may be due to a spin-forbidden singlet-triplet system or to a symmetry forbidden singlet system. Wavelengths and a photograph are given. A. G. GAYDON

535.343.9–14

4022. A microwave spectrum of the free OH radical. T. M. Sanders, Jr, A. L. Schawlow, G. C. Dousmanis and C. H. Townes. Letter in *Phys. Rev.*, **89**, 1158–9 (*March* 1, 1953).

Using a radiofrequency discharge in H_2O vapour to produce OH radicals and Zeeman modulation for detection, transitions between members of the Λ-type doublets are observed together with a nuclear hyperfine structure and Zeeman effect. The transitions are assigned and the parameters evaluated. D. H. WHIFFEN

535.345

4023. The transmittance of crystalline cadmium fluoride. H. M. Haendler, C. M. Wheeler, Jr and W. J. Bernard. Letter in *J. Opt. Soc. Amer.*, **43**, 215–16 (*March*, 1953).

A single crystal has been grown and its transmittance in the region 0·203 μ–13 μ is given. Practical methods of optical working of the crystal are described. The transmittance is high in the region 2 μ–9 μ but decreases rapidly between 9 μ and 13 μ. It is suggested that the material is useful as an optical window in the region 0·5 μ–10 μ, particularly for investigations on some corrosive materials. R. W. FISH

535.345–31 : 541.64

4024. Ultra-violet absorption by high polymers. G. Scheibe and R. Fauss. *Kolloid Z.*, **125**, 139–49 (1952) *In German.*

The uses of u.v. absorption measurements in the chemistry of high polymers are reviewed. These include estimation of functional groups, detection of impurities, determination of structure, use of polarized u.v. light to determine the intra-molec. orientation of absorptive groups in molecules oriented by streaming, crystals and fibres, and the effects of changes in pH on the structures of proteins (fluorescence quenching is sometimes more sensitive). It is necessary to correct for light scattering by large molecules.

BRITISH ABSTRACTS

535.347

4025. Note on the Cotton effect. R. Servant. *Rev. Opt.*, **32**, 34–8 (*Jan.*, 1953) *In French.*

After summarizing the characteristics of anomalies of natural or paramagnetic rotatory dispersion, the author shows that they are formally connected with one and the same phenomenon which can finally be considered as specifying the Cotton effect: the existence of a circular dichroism (natural or induced) which is maximum at the centre. A.

535.371

4026. Activation of lithium iodide by europium. J. Schenck. Letter in *Nature* [*London*] **171**, 518–19 (*March* 21, 1953).

Lithium iodide crystals 2 cm dia. by 1·5 cm long containing 0·05 mol % europium chloride were grown from melt. Response to γ-rays was 36% of that for NaI–Tl crystals and the decay time 2 μsec. A resolution of 6% (full width at half maximum/mean pulse height) was shown for the 4·875 MeV products of the $Li^6(n, \alpha)H^3$ reaction. G. F. J. GARLICK

535.371

4027. Sensitized electroluminescent response. H. C. Froelich. Letter in *J. Opt. Soc. Amer.*, **43**, 320 (*April*, 1953).

H_2S-fired ZnS.Mn does not show electroluminescence unless sensitized by Cu. The max. effect is for a 20 : 1 molar ratio of Mn to Cu retained after removing undissolved Cu sulphide. S. T. HENDERSON

535.371

4028. The fluorescence of biacetyl vapor. H. J. Groh, Jr. *J. chem. Phys.*, **21**, 674–8 (*April*, 1953).

It has been shown that the fluorescence of biacetyl vapour at 25°c excited with 3650 Å radiation does not decay as a simple exponential function of time. After flash excitation, there is a "fast" fluorescence followed

by a slow exponential decay. The quenching of the fluorescence has also been studied at several temperatures, pressures, and in the presence and absence of O gas. A consideration of this and previous work permits a further elucidation of the fluorescence phenomena in terms of two upper emitting states. Fluorescence from the state responsible for most of the fluorescence at room temperature is quenched strongly by O and is apparently completely removed at 200°. Fluorescence from the other state is unaffected by O and is still measurable at 200°. A.

535.371

4029. Note on the properties of calcium silicate phosphors. J. H. SCHULMAN, R. J. GINTHER AND E. W. CLAFFY. Letter in *J. Opt. Soc. Amer.*, **43,** 318 (*April*, 1953).

Samples of α-$CaSiO_3$ were fired with PbF_2 at 1000° or 1200°c, and β-$CaSiO_3$ similarly at 1000°. The products retained their initial crystal structure, and were measured for their reflection, excitation and emission characteristics. The α-samples have an excitation peak at 2350 Å, the β-samples at 2600 Å. Under 2300 Å excitation only the α-forms emit, with peaks at 2950 Å and 3900 Å. Under 2600 Å excitation both α- and β-forms show an emission peak at 3500 Å.

S. T. HENDERSON

535.371

4030. Electronic transitions in the luminescence of zinc sulfide phosphors. R. H. BUBE. *Phys. Rev.*, **90,** 70–80 (*April* 1, 1953).

The electronic transitions involved in the processes of (1) absorption, (2) excitation, (3) emission, (4) trapping and (5) photoconductivity, at room temperature, have been measured for ZnS phosphors, without added impurity, and with Ag, Cu and Mn impurity. Three types of excitation transitions are found: (1) from the filled band to the conduction band, (2) from an impurity level above the filled band to the conclusion band, and (3) from a ground-state level to an excited-state level of an impurity ion. The first two transitions result in trapping and photoconductivity; the third does not. Emission transitions occur from a level below the bottom of the conduction band to a level above the filled band. The same five major trap depths are common to all ZnS phosphors regardless of the nature of the impurity. Optical trap emptying by visible light, like thermal trap emptying, involves a process of stimulation in which trapped electrons are raised into the conduction band before returning to luminescence centres to produce emission. A tentative energy-level diagram is constructed from the data obtained. A.

535.371 : 535.345 : 537.583

4031. A study of the luminescence of and optical absorption in barium oxide as a function of temperature and thermionic activity. V. L. STOUT. *Univ. Microfilms Publ. No.* 2903 (1951) 123 *pp.* (*Photoreproduction.*)

Abstract in *Microfilm Abstracts*, **11,** *No.* 4, 1086–7 (1951).

535.375.5

4032. The effect of a strong electrostatic field on scattering. L. SINGH. Letter in *Proc. Phys. Soc.* [*London*] *A*, **66,** 309 (*March*, 1953).

The observed Raman lines of CCl_4 are slightly displaced to longer wavelength when the substance subjected to an electrostatic field. G. I. W. LLEWELY

535.375..

4033. The Raman effect of $N_2O_4 . 3\,SO_3$ a $N_2O_5 . 3\,SO_3$. H. GERDING AND K. ERIKS. *Recu Trav. chim. Pays-Bas.*, **71,** 773–8 (*July*, 1952).

The preparation of a compound corresponding t the formula $N_2O_5 . 3SO_3$ is given. Neither in th manner of preparation described by Pictet and Kar nor in other way was a stable compound of compos tion $N_2O_5 . 4SO_3$ obtained. The Raman spectrun of solid $N_2O_5 . 3SO_3$ and of a solid preparation of th average composition $N_2O_4 . 3SO_3$ are determined It may be concluded that $N_2O_5 . 3SO_3$ has to b considered as $(NO_2^+)_2 . S_3O_{10}^{--}$, whereas the produc of formula $N_2O_4 . 3SO_3$ contains NO_2^+ and NO^+ ion besides the same negative ions $S_3O_{10}^{--}$. A

535.375.55

4034. On the Raman spectrum of thianthrene in the molten state. S. K. MUKERJI AND B. LAL. *Indian J Phys.*, **26,** 276–8 (*June*, 1952).

The Raman spectrum of thianthrene in the molten state has been studied for the first time by using specia technique for its purification and to get rid of fluores cent background. The lines are at 3052(6), 2789(5), 1567(8), 1273(4), 1123(10), 1033(10), 768(2), 668(3), 305(4), 244(4) and 159(4) cm^{-1} respectively. An anti-Stokes line at 159 cm^{-1} has also been recorded. The Raman frequencies obtained in the molten state have been compared with those already obtained in the solid state. The lines of very low frequency which appeared in the solid state, have not appeared in the molten state, thus lending support to the view that these lines are characteristic of the solid state. A.

535.376

4035. The decay in fluorescence efficiency of organic materials on irradiation by particles and photons. F. A. BLACK. *Phil. Mag.*, **44,** 263–7 (*March*, 1953).

Measurements have been made of the damage caused by α-particle irradiation of several materials; some results are given for electron and ultraviolet irradiation. A comparison of the fluorescence efficiency for α-particle and electron excitation for these materials is made. The implication of the results is discussed in some detail, and analysis leads to a new understanding of the abnormally low α-particle fluorescence yield in organic materials. A.

535.376

4036. The alpha-particle induced phosphorescence of silver-activated sodium chloride. C. E. MANDEVILLE AND H. O. ALBRECHT. *Phys. Rev.*, **90,** 25–8 (*April* 1, 1953).

Using as primary excitants ultraviolet light and polonium α-particles, the phosphorescent afterglow of the double banded phosphor, Ag-activated NaCl, has been measured as a function of the time with photosensitive Geiger counters and photomultiplier tubes. The decay curves of the phosphorescent intensity of the two bands can be represented by appreciably different power laws. Decay slopes greater in absolute magnitude than two on a log I—log t plot have been frequently observed. A.

535.39

4037. On the lamellar reflectivity for multiple reflections. S. NAWATA. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **3**, 107–17 (*Feb.*, 1951).

The lamellar reflectivity of a single layer on a basic material can be interpreted as a reflection from a single surface of a hypothetical medium. Consequently, the reflection from two thin films on a basic material, namely, from three boundaries, can be reduced to the case of a single layer on the above hypothetical medium. Then, if the optical constants (n, k) of this hypothetical medium are deduced and these constants are used for those of the resultant layer, the lamellar reflectivity from two films on a basic material can be calculated, This process can be applied to multiple films on a basic material. The mathematical analysis of the lamellar reflection from a thin film or multiple thin films on a basic material was made, and these calculated results were compared with the published experimental data, and a reflection type interference filter with ZnS dielectric layer on an opaque aluminium mirror was produced. This method of calculation may be used in producing the interference filters, multilayer films of high reflecting power, and in reducing the reflection from glass by multilayer films, etc. A.

535.39

4038. Application of the variational calculus to the determination of reflection coefficents. L. RONCHI AND G. TORALDO DI FRANCIA. *Rev. Opt.*, **31**, 481–4 (*Nov.*, 1952) *In French.*

Application to a stratified medium is described. A.

535.39 : 539.234

4039. On the phase shift accompanying reflection of light from evaporated films and the change of effective refractive index as function of the thickness of deposit. S. NAWATA. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **3**, 740–7 (*Dec.*, 1951).

For the calculation of phase shift accompanying reflection from a thin film on a base metal medium, the author used the surface of hypothetical single medium with an effective refractive index for the surface of lamella with one layer on such a medium and expanded this method into the case of reflection from multiple layers. The phase shift and effective refractive index as function of the evaporated thickness were calculated in the limited cases of interest in optical practice, and if the dielectric deposit is evaporated and this lamella has the thickness with minimum or maximum resultant reflectivity, the following relations may be established at these thicknesses: (1) the n term of effective refractive index turns to minimum or maximum value, respectively; (2) the k term of effective refractive index turns to zero in all cases; (3) the curve of phase shift corresponds to the point of inflection. These relations also hold true in multiple dielectric layers on a base medium. The phase shifts of air/Al, air/[Al(opaque) + ZnS], air/[Al (opaque) + $MgF_2(\lambda_0/4)$ + ZnS] interfaces were observed as a function of the thickness of the final film from the displacement of Fizeau fringe. A.

535.412

4040. Numerical evaluation of the intensity curve of a multiple-beam Fizeau fringe. K. KINOSITA. *J. Phys. Soc. Japan*, **8**, 219–25 (*March–April*, 1953).

The intensity distribution curve of a multiple-beam Fizeau fringe is numerically evaluated for a typical case: normal incidence, R (the reflectivity of Ag film) $= 0{\cdot}90$, θ (the wedge angle) $= 3\times10^{-3}$ rad., and the order of fringe $t/\frac{\lambda}{2} = 6$, where t represents the thickness of the wedge at the point where the fringe is formed and λ the wavelength of light. The main maximum is about 80% as high as that of the corresponding Fabry–Perot fringe, and is slightly asymmetric. Secondary maxima suggested by Brossel are verified. They are restricted to one side of the main maximum in which the wedge is thicker. The cause of the asymmetry of the main maximum and the origin of secondary maxima are discussed. A.

535.417

4041. Intensity considerations in Lummer–Gehrcke plate. M. S. SODHA. Letter in *J. sci. industr. Res.*, **11B**, 395–6 (*Sept.*, 1952).

Calculations are made for the resolving power of a Lummer plate taking into account the absorption of the material which will progressively weaken the higher-order beams. A formula is given which includes the absorption coefficient of the material in the expression for resolving power. S. TOLANSKY

535.417

4042. Modern interferometers. C. CANDLER. *London: Hilger and Watts* (1951) 502 *pp.*

Review in *Nature* [*London*] **171**, 321 (*Feb.* 21, 1953). "Generally discusses a whole range of instruments in a more-or-less arbitrary order. . . . very suitable for the practical scientist who wishes to learn something about an instrument he has to use. Two-thirds of the book are devoted to interferometers, and the remainder to diffraction gratings."

535.42

4043. Study of the diffraction figure of a three-aperture system. C. RÉNET AND J. VIÉNOT. *Rev. Opt.*, **32**, 27–33 (*Jan.*, 1953) *In French.*

Shows that it is theoretically possible to set with high precision a system of fringes produced by screens of appropriate forms in image planes $\pm\lambda/4$ out of focus. It has been found necessary to re-specify certain known theoretical ideas for the purpose applying them to the construction of a high-sensitivity gas differential refractometer. The characteristics of this apparatus and the results of the first set of measurements are given. These enable the detection of variations of the refractive index in the eighth or ninth decimal place. A.

535.42 : 535.317.1

4044. Partial coherence and transmission functions. P. M. DUFFIEUX. *Rev. Opt.*, **32**, 129–42 (*March*, 1953) *In French.*

The conditions under which a definition can be given of the partial coherence of two elements of a plane, x, y relative to an observation plane u, v correspond to the case where the images in the plane u, v result from a homogeneous dissipation. The characteristic functions of the two planes are related by the Fourier transform. The coherence factor of two elements of the plane x, y (preferably called their

coupling) is readily deduced from the transmission functions characterizing the plane x, y. It results from a discussion of these functions that the empirical definition of coherence factors does not rid optics of any of the difficulties due to the dogma of coherence. An experimental method is described for determining the energy pupil which gives the coupling or the coherence factor for all pairs of elements in this plane.

A.

535.43 : 535.5

4045. Scattering by magnesia of polarized light. D. Blet-Talbot. *C.R. Acad. Sci.* [*Paris*] **236,** 476 (*Feb.* 2, 1953) *In French.*

If α and β are the angles of incidence and observation and θ is the angle between the planes of incidence and observation, then the intensity I of the light scattered varies with θ and is greater the greater β. The maximum intensity occurs when $\theta = 90°$ and 270° for vibrations parallel to the plane of incidence, and when $\theta = 0$ and 180° for vibrations perpendicular to this plane.

H. G. JERRARD

535.65

4046. An automatic colorimeter. H. Dijkstra and B. S. Sieswerda. *Appl. sci. Res. B,* **2,** *No.* 6, 429–53 (1952).

The colorimeter is photoelectric and may be used for continuously recording the absorption of a liquid flowing through the measuring cuvette; at the same time it offers the possibility of operating a regulating device for controlling a continuous chemical process. These colorimeters can easily be manufactured in series; the recording is not affected by the age of the various parts and by fluctuations in voltage and frequency of the mains. The reproducibility of the results obtained with the apparatus described, measured over a period of weeks, is about $\frac{1}{2}\%$. Measured over shorter periods it is about $\frac{1}{10}\%$ of the full deflection. However, this reproducibility may be increased considerably.

A.

535.7 : 612.84

Physiological optics. *See Abstr.* 4526–32

535.822.9

4047. An interferometer microscope for opaque objects. J. Dyson. *Proc. Roy. Soc. A,* **216,** 493–501 (*Feb.* 24, 1953).

Two existing methods for the examination of the surfaces of opaque objects are reviewed with their respective merits and disadvantages. A new method is described which obviates most of these disadvantages but which is simple in operation and involves inexpensive equipment. The instrument described involves the use of a single objective with a preceding optical system and can be used on a conventional microscope stand. The aperture is unrestricted, and the lateral resolution of the microscope is not impaired. To illustrate the utility of the method, some applications are described and the results presented as photographs.

A.

535.822.9

4048. The ultraviolet microscope. E. W. Taylor. *J. Opt. Soc. Amer.,* **43,** 299–305 (*April,* 1953).

A form of ultraviolet microscope of the refracting type is described in which the source of radiation is a spark gap between fixed or rotating electrodes and the objectives are normally monochromats. The microscope is horizontal, thus avoiding the use of a mirror, and the fine motion mechanism responds to movements of 0·10 micron. Phase contrast may be used for visual scanning of the object and also for photography in the ultraviolet. The source of radiation can be supplied as a separate unit and used in conjunction with metallurgical microscopes of normal type to enable photographs of opaque objects to be taken in the ultraviolet. Some examples of microphotographs taken with the equipment described are appended, together with particulars.

A.

535.822.9 : 531.717.31

4049. Shadow microscopy for measurement of height. S. Tolansky. Letter in *Nature* [*London*] **171,** 564–6 (*March* 28, 1953).

A technique is described which permits measurement to be made of the heights of small particles and surface contours by an optical shadow method. The surface receiving the shadow is specially prepared. Shadow magnifications of ×12 the object heights are recorded with microscope magnifications of ×240 (total magnification 2900). The technique is applied to spores and to surfaces of diamonds.

S. TOLANSKY

535.824.2

4050. Catadioptric microscope objectives with concentric mirrors. B. S. Blaisse, A. Bouwers and H. W. Bulthuis. *Appl. sci. Res. B,* **2,** *No.* 6, 453–66 (1952).

Microscope objectives are described in which the aberrations of two mirrors compensate each other, and in which residual aberration is reduced and the numerical aperture increased by lenses. The all-glass objectives are designed to have a low obstruction ratio (< 4% in area), wide field of view and large working distance. Design details and residual aberration curves are given for both dry and immersion types.

R. W. FISH

HEAT 536

536.22

4051. Theory of thermal conductivity of water. M. Eigen. *Z. Elektrochem.,* **56,** *No.* 3, 176–80 (1952) *In German.*

The irregular conductivity of H_2O, as compared with non-metallic liquids, is due to the association of H_2O molecule in the liquid state. Thus the conductivity can be separated into two parts, $\lambda_N + \lambda_A$, where λ_N is the "normal" value and λ_A that due to the associates. The former is calculated in the normal way and λ_A in a manner analogous to Nernst's method for dissociating gases. A diffusion mechanism for the transport of the heat of dissociation is developed, based on Eucken's association structure for H_2O. Quantitative agreement between the calculated and observed results for the absolute value of the conductivity and its variation with temp. is obtained.

BRITISH ABSTRACTS

536.24

4052. Temperature rise in a heat-producing solid behind a surface defect. C. J. TRANTER. Letter in *J. appl. Phys.*, **24**, 369 (*March*, 1953).

Presents an alternative solution, involving the solution of a pair of dual integral equations, for the case when the temperature field of a semi-infinite solid in which heat is being produced is disturbed by the introduction, at the boundary, of an infinite insulating region in the form of a strip [Abstr. 798 (1953)]. F. LACHMAN

536.25 : 532.5 : 550.311

4053. The onset of convection by thermal instability in spherical shells. S. CHANDRASEKHAR. *Phil. Mag.*, **44**, 233–41 (*March*, 1953).

The problem of the thermal instability of an incompressible sphere consisting of an inviscid core and a viscous mantle is considered, and it is shown that the pattern of convection which sets in, at marginal stability, in the mantle shifts to harmonics of the higher orders as the thickness of the mantle decreases. Thus, when the mantle extends to a depth of half the radius of the sphere, the harmonics of orders three and four set in about simultaneously, while the harmonic of order five follows very soon afterwards. The bearing of this result on the problem of convection in the earth's mantle and of the interpretation of the earth's topographic features is indicated. See also Abstr. 1574 (1953). A.

536.413

4054. On the abnormality in the thermal expansion of iron–platinum alloys. H. MASUMOTO AND T. KOBAYASHI. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **2**, 856–60 (*Dec.*, 1950).

Based on the rule concerning Invar, previously proposed by one of the writers (1929), measurements on the thermal expansion of binary alloys of Fe and Pt were carried out, and it was found that the alloys containing $52{\cdot}5 \sim 53{\cdot}5\%$ of Pt have, at the vicinity of room temperature, negative coefficients of expansion and that the smallest value of the mean linear coefficient of expansion is $-12{\cdot}5\times10^{-6}$ for the alloy of 53% of Pt in the range of temperature $0 \sim 40°$C. A.

536.423.4 : 533.7

4055. Remarks on the theory of fusion and condensation. A. J. F. SIEGERT. *Phys. Rev.*, **90**, 97–102 (*April* 1, 1953).

A re-examination of the relation between the thermodynamic functions and the energy level density ρ of a substance consisting of N interacting particles for a class of hypothetical but (in the case $1 \ll N \ll 10^{23}$) not unreasonable functions ρ defined by certain regularity conditions. It is shown that the specific features of ρ which lead to condensation—in the sense of a discontinuous change of the most probable volume—under a volume independent force per unit area can yield partition functions which, in the condensation region, are smooth and of a shape similar to the van der Waals function. This is not a contradiction since for a substance under a volume independent force, the results of the conventional *ad hoc* re-interpretation of the van der Waals curve can be proved directly from the canonical ensemble, without the *ad hoc* assumptions. A.

536.424 : 538.24

4056. On the magnetometric studies of transformation in pure manganese. M. ISOBE. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **3**, 78–81 (*Feb.*, 1951).

The transformation points in pure distilled Mn were magnetometrically investigated by the modified Weiss method. It was found that Mn had four phases, α, β, γ and δ, in the solid state and that the three transformation points were 702, 1065 and 1138°C, respectively. The melting point of pure Mn was 1252°C. The behaviour of these transformations was also clarified. A.

536.44

4057. Some additional remarks on a hypothesis concerning the critical state. J. VAN DRANEN. Letter in *J. chem. Phys.*, **21**, 567–8 (*March*, 1953).

Continuation of a previous paper [Abstr. 8127 (1952)]. More refined calculations of the potential energies of A, N_2 and CH_4 give some support to the author's theory that at the critical point the average kinetic energy is equal to the average (negative) potential energy. R. C. MURRAY

536.48

4058. Quantum-mechanical treatment of viscosity coefficient of helium by use of a rigid sphere model with attractive force. K. HIROTA. *Bull. Chem. Soc. Japan*, **22**, 16–20 (1949).

A rigid-sphere molec. model in which the inverse-cube law of attractive force applies is adopted. This is used to calculate by quantum mechanics the viscosity coeff. of He. The divergence between theory and experiment is smaller at low temp. than in treatments postulating no attractive force.

BRITISH ABSTRACTS

536.48

4059. The macroscopic theory of superfluid He^3–He^4 mixtures. P. J. PRICE. *Phys. Rev.*, **89**, 1209–15 (*March* 15, 1953).

The macroscopic hydrodynamic equations to the reversible linear approximation for mixtures are set up and analysed, without making any assumptions beyond that of the traditional form of the two-fluid model. The equations of wave motion are derived and discussed. A novel feature of them is appreciable coupling between pressure and entropy-density fluctuations. It is shown how the constants appearing in the equations may be expressed partly in terms of the measured partial vapour pressures. Pomeranchuk's formula for the velocity of second sound appears as a possible special case; and it is shown how his assumption that the He^3 component is carried entirely with the normal velocity may be tested experimentally. The intervention of isotopic diffusion is briefly discussed. A.

536.48

4060. The formation of the helium film. D. F. BREWER AND K. MENDELSSOHN. *Phil. Mag.*, **44**, 340–3 (*March*, 1953).

The formation of the unsaturated He II film has been studied by measurements of superfluidity and adsorption isotherms on glass between $1{\cdot}35°$K and $2{\cdot}27°$K. Whereas with decreasing percentage saturation the onset of superflow is depressed to lower temperatures, the coverage shows a discontinuity

at the normal λ-point of the bulk liquid. Formation of liquid clusters has been advanced as a possible explanation, and the existence of an anomalous surface tension effect has been suggested. A.

536.48

4061. Further observations on the helium II film by an optical method. L. C. JACKSON AND D. G. HENSHAW. *Phil. Mag.*, **44**, 14–18 (*Jan.*, 1953).

Further studies have been made using the optical method of Burge and Jackson [Abstr. 2629 (1951)]. Evidence has been obtained that there is a film of He I at 2·3°K about 10 atoms thick, but accurate values of this thickness have not yet been obtained. It has been shown that the thickness of the creeping film of He II does not change when the volume of liquid flowing per second in the film decreases considerably and that the thickness is equal to that of the stationary film under the same conditions. Bulk liquid is seen to form when the He II film flows on to a surface (i) which is below the highest liquid level and (ii) which has a perimeter smaller than that which controls the rate of creep. The bulk liquid returns to the film if the latter then flows on to a surface with a perimeter at least as great as the controlling perimeter. A.

536.48

4062. Some reflections on phonons and rotons. H. A. KRAMERS. *Physica*, **18**, 653–64 (*Oct.*, 1952).

The statistical distribution function for "excitons" moving relative to a supposedly stationary liquid is derived by considering the conditions for equilibrium when they are imagined to be trapped within a semi-permeable net moving through the liquid. The fountain pressure is calculated from the resultant momentum transport, and the velocity of second sound from the laws of conservation of momentum and energy. It is concluded from the law of conservation of mass that the energy-wave number relation for excitons is of the form $E = \hbar c(k^2 + k_0^2)^{\frac{1}{2}}$, with $k_0 = 0$ for phonons. The suggestion is made that the existence of all excitons except phonons is primarily connected with the atomistic structure of the liquid. R. B. DINGLE

536.532

4063. Average temperatures by parallel-connected thermocouples. B. E. DRIMMER. Letter in *J. appl. Phys.*, **24**, 225–6 (*Feb.*, 1953).

Twenty couples embedded in a steel cylinder are connected in parallel to give a measure of the average temperature to better than 1%, provided the resistance of the branches are equal within easily obtained limits. The theory is outlined and briefly applied to a steel bar 13 cm long. E. H. DOCK

536.532 : 537.324

On the theory of the thermocouple. *See Abstr.* 4113

536.63 : 538.222

4064. The thermal and magnetic properties of palladium–silver alloys. F. E. HOARE, J. C. MATTHEWS AND J. C. WALLING. *Proc. Roy. Soc. A*, **216**, 502–14 (*Feb.* 24, 1953).

The magnetic susceptibilities of a series of Pd–Ag alloys from pure Pd to approximately 50 atomic % Ag, have been measured over a range of temperature from 20 to 290°K. The specific heats of a similar series of alloys have been measured in the temperature range 11 to 20°K, and the results used to deduce the electronic specific heats. Owing to the variation of the Debye characteristic temperature with temperature these values are not considered to be of high precision beyond 15% Ag content. Making a reasonable correction, however, it has been possible to deduce the band form for Pd. By extrapolation of the susceptibility results to 0°K the variation of Stoner's exchange interaction parameter with concentration has been investigated over a limited range. A.

THERMODYNAMICS 536.7/.8

536.7

4065. *W* log *p* diagrams of methane and ethylene. W. H. KEESOM, A. BIJL AND L. A. J. MONTÉ. *Appl. sci. Res. A*, **3**, *No.* 4, 261–71 (1952) *In French.*

The enthalpy/log *p* diagrams are given, with details of the reduction of the experimental data. The accuracy of the final values, as given by thermodynamical cross checks, is indicated. F. E. HOARE

536.7

4066. On Onsager's relations. J. E. VERSCHAFFELT. *Bull. Acad. Roy. Belgique Cl. Sci.*, **38**, *No.* 11, 1021–5 (1952) *In French.*

A criticism of the supposition of S. R. de Groot (Thermodynamics of Irreversible Processes) that the reciprocal relations established between material fluxes apply also to the diffusion flux. It is shown that this is not valid. F. E. HOARE

536.7

4067. Thermodynamics of irreversible processes. S. R. DE GROOT. *Amsterdam: North-Holland Publishing Company; New York: Interscience Publishers* (1951) xvi + 242 *pp.*

Review in *Quart. appl. Math.*, **10**, 400 (*Jan.*, 1953).

536.7 : 536.75

4068. On the minima of energy dissipation. J. E. VERSCHAFFELT. *Bull. Acad. Roy. Belgique Cl. Sci.*, **38**, *No.* 10, 908–33 (1952) *In French.*

The author shows the correct manner of treating this problem and then comments on the treatment of the analogous problem of minimum entropy production by other authors. Some reflections on stationary states are added. F. E. HOARE

536.7 : 539.213

The irreversible approach to equilibrium in glasses. *See Abstr.* 4401

536.71 : 530.162

4069. The isotherms of an imperfect gas. D. TER HAAR. *Proc. Cambridge Phil. Soc.*, **49**, *Pt I*, 130–5 (1953).

The liquid drop model of an imperfect gas in the form introduced by Wergeland is discussed by using the method of the grand ensembles, and the equation of state of the system is derived. This equation of state is of the same general type as the one derived by Mayer for a more general model. It is shown that in both cases the isotherms consist of two analytically different parts in the limit where the number of particles in the system, *N*, goes to infinity. A.

ELECTRICITY 537

THEORY . ELECTRONS 537.1

537.12/.13

4070. Direct comparison of m/e for the positron and the electron. L. A. PAGE, P. STEHLE AND S. B. GUNST. *Phys. Rev.*, **89**, 1273–7 (*March* 15, 1953).

A relativistic, double-focusing mass spectrometer has been built to operate with 55 keV electrons. It has reversible electric field and fixed magnetic field. Positrons from Na^{22} and electrons from a hot filament alternately follow identical trajectories in opposing directions. The magnitude of the electric field required to focus is used as the measure of m/e. Seventeen positron runs were made intermediate in time between twelve electron runs. The r.m.s. deviation of the data lies within the standard deviation associated with positron counting. The result is

$$\frac{(m/e)^- - (m/e)^+}{m/e} = (26 \pm 71) \times 10^{-6},$$

where the uncertainty is the standard deviation. A.

537.12 : 532.5

4071. Hydrodynamic properties of an electron gas. B. E. HOWARD. *Univ. Microfilms Publ. No.* 2731 1951) 74 *pp.* (Photo-reproduction.)

Abstract in *Microfilm Abstracts*, **11**, *No.* 4, 1050–1 (1951).

ELECTROSTATICS . DIELECTRICS 537.2

537.217 : 539.61

Electrical phenomena in adhesion. I. Electron atmospheres in dielectrics. *See Abstr.* 4433

537.226.1

4072. The dielectric properties of two-body systems. H. FRICKE. *Experientia*, **8**, *No.* 10, 376–7 (1952).

Theoretical discussion of the dielectric properties of a suspension in terms of the shape and electrical properties of the components. D. H. WHIFFEN

537.226.2

4073. The properties of KH_2PO_4 below the Curie point. H. M. BARKLA AND D. M. FINLAYSON. *Phil. Mag.*, **44**, 109–30 (*Feb.*, 1953).

The study of the dielectric, piezoelectric and elastic properties of KH_2PO_4 has been extended into the ferroelectric range of temperatures, and should permit further theoretical consideration of the behaviour of this group of crystals. In addition to the main transition, the treatment of which is still inadequate, there is another transition for which no complete explanation can yet be given; this second characteristic temperature marks the onset of a steep rise of coercive field with decreasing temperature. A qualitative domain theory is presented to account for the main features of the ferroelectric state in KH_2PO_4. A.

537.226.2

4074. Selenium hexafluoride: dielectric strength and some chemical properties. A. A. BANKS AND A. J. RUDGE. Letter in *Nature* [*London*] **171**, 390–1 (*Feb.* 28, 1953).

537.226.2

4075. Dielectric relaxation and the internal field. J. G. POWLES. *J. chem. Phys.*, **21**, 633–7 (*April*, 1953).

Discusses the relation of the relaxation time τ of a dielectric to the measured decay time of polarization T and proposes a new expression for the internal field in a dielectric subjected to an alternating field. It is found for this expression that $1 < T/\tau < \frac{3}{2}$ and that in most instances no serious error is incurred in using T instead of τ. Application to the case of several distinct relaxation times shows that the new expression gives relations between the complex dielectric constant and frequency which are observed experimentally. A.

537.226.2

4076. The dielectric constants of water/ethyl alcohol mixtures. A. P. ALTSHULLER. Letter in *J. chem. Phys.*, **21**, 562 (*March*, 1953).

537.226.2

4077. Microwave observation of the collision frequency of electrons in germanium. T. S. BENEDICT AND W. SHOCKLEY. Letter in *Phys. Rev.*, **89**, 1152–3 (*March* 1, 1953).

Measurements of attenuation and phase shift at wavelengths of 1·24 cm over the temperature range 298 to 160°K were used to determine the dielectric constant of single crystals of very pure n-type Ge. From the results the effective mass of the conduction electrons is 0·6 times the free electron mass and the relaxation time is $6{\cdot}6 \times 10^{-9} \times T^{-3/2}$ sec.

C. A. HOGARTH

537.226.2

4078. Ferroelectricity in oxides of face-centred cubic structures. W. R. COOK, JR AND H. JAFFE. Letter in *Phys. Rev.*, **89**, 1297 (*March* 15, 1953).

537.226.2

4079. Dielectric constant and permeability of various ferrites in the microwave region. T. OKAMURA, T. FUJIMURA AND M. DATE. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **4**, 191–202 (*April*, 1952).

These were determined on various simple polycrystalline specimens of Mg, Cu, Co, Ni and Mn ferrites quenched or slow-cooled from high temperatures at 6·6 cm wavelength by observing changes in Q-value and frequency shift when a thin disk-formed specimen, whose dia. is 20 mm and thickness is 1 mm or 1·5 mm, attached on a supporter, was inserted in the rectangular cavity (TE_{104} mode) at the positions of the electric and magnetic field maxima, respectively. From these measurements, both the real and the imaginary parts of ε and μ were determined from the formulae derived by expanding the field in the cavity, using the orthogonal function introduced by Slater. A.

537.226.2 : 541.183

Dielectric properties of vapors adsorbed on silica gel. I. *See Abstr.* 4453

537.226.2 : 621.3.011.5 : 621.315.59 : 621.318.1

4080. Dielectric behaviour of granular semi-conducting aggregates, with special reference to some magnesium ferrites. A. FAIRWEATHER AND E. J. FROST. *Instn Elect. Engrs Paper* 1486, 8 *pp.* (1953).

Deals with members of a family of ferrites derived from $MgFe_2O_4$ by replacement of Fe by Al. Their

high permittivities and dispersions are due to conductivity and the inhomogeneity arising from the contact structure of intergranular boundaries. The paper gives a more detailed picture of the boundary, and draws attention to the significance of measurements made at different temperatures and with a steady bias voltage. A 4-element equivalent circuit gave an adequate means of describing behaviour. Choice of material for specific applications can be made on the basis of such measurements. I. D. L. BALL (R)

537.226.8

4081. Low frequency dispersion in Ni- and Co-ferrites. K. KAMIYOSHI. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **3**, 716–24 (*Dec.*, 1951).

Low frequency dielectric dispersion was observed in both Ni and Co ferrites, and it was shown that both Koops's double layer model and Debye's dispersion formula for solid dielectric are in agreement with the present result. The activation energies were calculated from the temperature dependence of the resonance frequency, and these values were found to coincide with those obtained from the result of electrical conductivity measurements which were made on the same sample. See also Abstr. 280 (1952). A.

537.226.8

4082. The polarization fields and the resonance frequencies of the alkali halide crystals. K. S. KRISHNAN AND S. K. ROY. *Phil. Mag.*, **44**, 19–32 (*Jan.*, 1953).

The effect of the polarization field on the dielectric constant of a medium can be taken into account in two alternative ways, which are equivalent. It may be regarded as enhancing the actual field that produces the polarization, or as determining the resonance frequencies of the medium, which will be different from the frequencies of the individual oscillators that constitute the medium. The dispersions of the alkali halides are discussed from the latter point of view. Though the polarization factors defining the interactions between the infrared oscillators have the Lorentz value $4\pi/3$, those defining the interactions of the electronic oscillators are found to be zero. The electronic overlap between the neighbouring ions in their equilibrium positions seems to be just the one that corresponds to negligible interactions between the electronic oscillators. A.

ELECTRIC CONDUCTION . CURRENTS 537.3

537.311.1 : 537.322 : 538.63

4083. The electrodynamic potential. J. E. VERSCHAFFELT. *Bull. Acad. Roy. Belgique Cl. Sci.*, **38**, *No.* 6, 593–606 (1952) *In French.*

Gives a fuller discussion of the idea of an electrodynamic potential [Abstr. 836 (1953)] and applies it to the Volta and Thomson effects, eddy current effects and to the various magnetoelectric and thermomagnetic effects. E. P. WOHLFARTH

537.311.1 : 539.234

4084. Resistivity of evaporated tellurium films. T. SAKURAI AND S. MUNESUE. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **4**, 96–104 (*Feb.*, 1952).

The resistivity was measured at various temperatures. When the substrate was kept at room tem perature during evaporation, the film shows log $R - 1/T$ curve, conspicuously different from tha of the bulk. By heat treatment or by electron bom bardment the resistivity was found to change irre versibly, becoming nearer to that of a bulk specime These features were explained by the crystallizatio of the amorphous deposit in the film. On the othe hand, when the Te was deposited on a hot substrat about 470°K in temperature, the resistivity of the fil was found to be in good accordance with that of th bulk, giving activation energies of 0·34 and 0·04 e in the intrinsic and the extrinsic range, respectively. A

537.311.3

4085. On the electric conductivity of B_2O_3-Na_2O and B_2O_3-K_2O systems in fused glassy state. S KINUMAKI AND K. SASAKI. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **3**, 258–64 (*April*, 1951).

Though the equation $\sigma = \sigma_0 e - E/RT$ can b applied to the relation between electric conductivit and reciprocal of absolute temperature in fairly pur fused boric oxide, addition of alkali oxide cause deviation from it. In a binary system, electric con ductivity takes the maximum value at about 20% Na_2O in the B_2O_3-Na_2O system and about 15% K_2O in th B_2O_3-K_2O system. A

537.311.3

4086. Electrical conductivity of single crystals o graphite. A. K. DUTTA. *Phys. Rev.*, **90**, 187–9 (*April* 15, 1953).

The electrical conductivities along the principa directions of graphite crystals have been measure using a large number of well-developed single crystal obtained from Ceylon. The conductivity along direction perpendicular to the hexagonal axis i about 10^4 times that along the axis. Rectification an other non-linear effects are totally absent. Thickne plays an important part in the determination of th conductivity normal to the hexagonal axis an attempts have been made to avoid this difficulty. These measurements have been extended to temperature between 80°K and 500°K. The conductivity perpen dicular to the hexagonal axis falls roughly exponentially with rising temperature and that along the axis rise similarly with temperature. A magnetic field has bee found to cause a decrease in both the conductivities— the effect on the conductivity normal to the hexagona axis being more pronounced. This decrement fall roughly exponentially with rising temperature and ha a tendency to attain a steady value at highe temperatures. A

537.311.32 : 538.63

4087. The electrical properties of graphite. G. H KINCHIN. *Proc. Roy. Soc. A*, **217**, 9–26 (*March* 24 1953).

The Hall coefficient and resistivity of a range o polycrystalline graphites with different crystal size and a single crystal of Travancore graphite have bee measured over a wide range of temperature. Th number of free electrons has been found to be approxi mately 6×10^{18} per cm^3 at room temperature; the varia tion with temperature cannot be accurately deter mined. The deficit of electrons in poorly crystallin graphite gives rise to positive Hall coefficients

Quenching removes electrons, and a study of this process has enabled the ratio of the mobilities of positive holes and electrons to be estimated at 0·80. An interesting effect has been observed in the variation of the Hall coefficient of the single crystal with field; no satisfactory explanation has been found for this phenomenon. The resistivity of polycrystalline graphite depends on the density and on the orientation and size of the crystals. From the variation of resistivity with temperature and the size of the crystals, the mean free path due to thermal scattering has been found to be 2350 Å at 273°K; the variation of mean free path with temperature has been deduced. The product of effective mass and velocity of the free electrons has been determined as a function of temperature; the accuracy is limited by uncertainties in the number of free electrons. A.

537.311.33

4088. On the width of forbidden energy zone of tellurium. T. FUKUROI. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **3**, 175–81 (*April*, 1951).

Deals with the width at absolute zero, and the variation which resulted both from the thermal dilatation and from the thermal vibration that are induced in the crystal lattice, when the temperature is increased. The amounts under investigation have been calculated in terms of the data of the effective masses, mobilities and concentrations of the conduction electrons and positive holes in the intrinsic temperature range, those which have been derived in the previous paper [Abstr. 3526 (1951)] by analysing the results of measurements on the resistivity, the Hall effect and the magneto-resistance of Te. The forbidden zone width, as the final result, is given approximately by $\Delta E = 0{\cdot}34 + 1{\cdot}7\times10^{-4}T$, in electron volts, as a function of the absolute temperature T. A.

537.311.33

4089. A study of the electrical properties of porous semiconductors. E. B. HENSLEY. *Univ. Microfilms Publ. No.* 2883 (1951) 88 *pp.* (Photo-reproduction.)

Abstract in *Microfilm Abstracts*, **11**, No. 4, 1082–3 (1951).

537.311.33

4090. Solubility and ionizability of impurities in germanium single crystals. W. DÜRR, J. JAUMANN AND K. SEILER. *Z. Naturforsch.*, **8a**, 39–46 (*Jan.*, 1953) *In German.*

Single crystals of Ge with various amounts of Ga, As or Sb added were formed under conditions of controlled cooling. By means of measurements of Hall coefficient R and conductivity σ of the rods and of the variation with temperature of R and σ of small specimens, the amounts and location of impurities (so far as concentration gradients are concerned) could be estimated. The Hall effect measurements, together with the knowledge of the total amount of any impurity added, enable the number of impurity atoms ionized to be calculated. The segregation coefficients are found to be 1/6·4, 1/23 and 1/140 for Ga, As and Sb respectively. C. A. HOGARTH

537.311.33

4091. Recombination rate in germanium by observation of pulsed reverse characteristic. E. M. PELL. *Phys. Rev.*, **90**, 278–9 (*April* 15, 1953).

A new method for measuring recombination rates of minority carriers in Ge is described in which the decay of injected carriers is observed directly as a function of time. In this method the geometry is relatively unimportant as long as the sample is large in comparison to the diffusion length, and the method permits measurement of recombination rates too short to be measured with light beam methods. Data are presented which show excellent agreement between this method and a light beam method. A.

537.311.33

4092. Electron spin in semiconductors. E. A. GUGGENHEIM. Letter in *Proc. Phys. Soc.* [*London*] *A*, **66**, 121–2 (*Jan.* 1, 1953).

It has recently been shown [Abstr. 8185 (1952)] that spin degeneracies of electrons at impurity centres lead to modifications of the usual Fermi–Dirac function as applied to localized levels. In this letter these improved formulae are derived in a general manner by basing the argument on a grand canonical ensemble. P. T. LANDSBERG

537.311.33 : 538.567

4093. Capacitance effects in thin conductive films. J. N. HUMPHREY, F. L. LUMMIS AND W. W. SCANLON. *Phys. Rev.*, **90**, 111–15 (*April* 1, 1953).

The frequency dependence of the resistance of thin films of PbS and Te is analysed in terms of distributed capacitance and intercrystallite capacitance. It is shown that for some films of either material the observed behaviour can be explained in terms of distributed capacitance alone, but that others require a combination of the two types of capacitance. An expected correlation between photoconductivity and the presence of intercrystallite capacitance was not found in these experiments. A.

537.311.33 : 621.3.066.6 : 621.314.6

4094. Temperature-variation of the rectification characteristics at selenium contacts. E. W. SAKER. Letter in *Proc. Phys. Soc.* [*London*] *B*, **65**, 990–1 (*Dec.*, 1952).

Results of rectification curves for Se/Au contacts at various temperatures are fitted to equations derived by Mott and by Landsberg and reasonable agreement is obtained at room temperature and above, but not always at temperatures below 0°C. The diffusion potential is temperature-dependent in the sense opposite to that predicted by Landsberg. C. A. HOGARTH (R)

537.311.33 : 621.315.59

4095. Shot noise in semiconductors. A. VAN DER ZIEL. Letter in *J. appl. Phys.*, **24**, 222–3 (*Feb.*, 1953).

The origin of shot noise is discussed in terms of fluctuating concentrations of free holes and electrons and the results of calculations of shot noise ratio (i.e. shot noise power to thermal noise power) are applied to various classes of semiconductor.

C. A. HOGARTH

537.311.33 : 537.312.5 : 621.314.7

4096. The properties of germanium phototransistors. J. N. SHIVE. *J. Opt. Soc. Amer.*, **43**, 239–44 (*April*, 1953).

Describes, summarizes and compares the properties of three photoelectric devices, namely: point contact phototransistors, *p–n* junction phototransistors and *n–p–n* junction multiplier phototransistors.

The first of these devices is characterized by a comparatively high dark current and a quantum yield of 3 or 4 electrons per quantum. The second has a dark current in the microampere range and a quantum yield of approximately unity. The *n–p–n* device has a sensitivity corresponding at best to a quantum yield of several hundred electrons per quantum. All these devices have long-wave thresholds around $1{\cdot}8\,\mu$. The structures lend themselves readily to miniature encapsulation. A.

537.311.33 : 621.314.7

4097. Pressure-welded *p–n* junctions in germanium. R. G. SCHULMAN AND D. M. VAN WINKLE. Letter in *J. appl. Phys.*, **24**, 224 (*Feb.*, 1953).

p–n junctions are made by welding two opposite-type crystals of Ge together. The joint is made by locally melting the contacting surfaces under pressure, localized pressures of 1000 kg/cm² being achieved by using extremely small contact areas. The principal features of junctions made in this way are high back saturation currents, and improved h.f. response, due to the short lifetime of the minority carriers in the distorted region of the weld. D. G. AVERY

537.311.33 : 621.314.7

4098. Transistor action and related phenomena in lead sulphide specimens from various sources. C. A. HOGARTH. *Proc. Phys. Soc.* [*London*] *B*, **66**, 216–20 (*March*, 1953).

Examination of a large number of specimens of PbS has indicated a maximum free carrier concentration at 290°K of 2×10^{17} cm^{-3} if transistor action is to be observed. This figure leads to a value of 0·65 eV for the width of forbidden band at 290°K. Transistor action is only observed in *p*-type specimens and is always associated with good rectification and a strong photovoltaic effect. A.

537.311.33 : 669.783 : 621.38

4099. Shot noise in germanium filaments. R. H. MATTSON AND A. VAN DER ZIEL. Letter in *J. appl. Phys.*, **24**, 222 (*Feb.*, 1953).

Measurements confirm that noise ratio between frequencies f from 1–1600 kc/s can be represented by $n = 1 + AI^2/f + BI^2/[1 + (f/f_0)^2]$ where I is current, and A, B and f_0 are constants for a particular specimen. The final term is interpreted as shot noise, and its origin is discussed in terms of excitation of electrons and holes from trapping centres. C. A. HOGARTH

537.311.4

4100. Electrical contact resistance between metallic surfaces subjected to various treatments. T. FUKUROI AND Y. MUTO. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **3**, 281–91 (*June*, 1951).

Contact resistance between two W rods, which are placed crosswise and pressed together with a pressure from 10 to 100 g, is measured over the temperature range from room temperature down to the boiling point of liquid N. The experiment is performed with the specimen subjected to three kinds of surface treatments: mechanical polishing, electrolytic polishing and etching. It is found that the contact resistance depends on the contact pressure and varies linearly with temperature, pursuant to the kind of surface treatment. From the experimental results, the contact resistance is considered as consisting of two parts, namely, the convergence resistance and the transit resistance which is independent of temperature. using these relations, the contact area and dista are estimated under certain assumptions. The re tionship between contact resistance and surface co dition is discussed.

537.312.5 : 621.38

4101. On the fatigue of Ag–Cs photoelectric tub G. KUWABARA. *J. Phys. Soc. Japan*, **8**, 223– (*March–April*, 1953).

The fatigue of Ag–Cs photoelectric tubes w measured for low-intensity light at room temperatu The results can be explained neither by the hypothe of de Boer nor by that of Suhrmann. The necessa conditions for obtaining a high accuracy in phot electric photometry with Ag–Cs phototubes we discussed.

537.312.5 : 539.11

4102. Photoelectric emission and energy structu of Cs_3Sb. H. MIYAZAWA. *J. Phys. Soc. Japan*, 169–73 (*March–April*, 1953).

Spectral distributions of the photoelectric yield ar energy distributions of the photoelectrons wer observed at room temperature, 195°K and 90°K fc Cs_3Sb. The facts obtained are as follows: (1) th quantum efficiency Y rises rapidly as $h\nu$ increase above 2 eV, and reaches the maximum at $h\nu \sim 3$· eV, where the magnitude of Y exceeds 10^{-1}; further there appears the second maximum at $h\nu \sim 5$ eV (2) for $h\nu \gtrsim 3$ eV Y increases with the decrease i temperature in accordance with the relatio $(\partial Y/\partial T)/Y \simeq -10^{-3}$/deg; (3) on the contrary, i the low-energy tails at $h\nu \sim 2$ eV Y decreases with decreasing temperature, or the photoelectric work function ϕ shifts with temperature in the form $\partial\phi/\partial T = -3 \sim 5\times10^{-4}$ eV/deg; (4) at lower tem peratures a minor hump in Y can be seen a $h\nu \sim 2{\cdot}2$ eV; (5) energy distributions are compara tively temperature-insensitive, but for $h\nu \sim 5$ eV corresponding to the second maximum in Y, there is a growing preponderance of low-velocity electrons which is quite unlike those for smaller $h\nu$. These results are discussed in terms of a possible energy structure for Cs_3Sb. A.

537.312.5 : 541.14

4103. The Becquerel effect in the presence of dye-stuffs and the action of light on dyes. P. J. HILLSON AND E. RIDEAL. *Proc. Roy. Soc. A*, **216**, 458–76 (*Feb.* 24, 1953).

When a dye is adsorbed on an electrode and is illuminated, a photo-current flows. The direction of the photo-current shows that the dye may be either oxidized or reduced, and a quantitative investigation has enabled the mechanism of the two reactions to be elucidated. The primary step in the reduction is the direct transfer of an electron from the electrode to an excited dye molecule, and the primary step in the oxidation is the reduction of water to hydrogen atoms by excited dye molecules. The different effects which have been found in photogalvanic experiments with dyestuffs, in solution or adsorbed on the electrode, can be interpreted on this basis, and the significance of these reactions in the bleaching of dyes and tendering of textiles by light is discussed. A.

537.312.5 : 621.317.71.014.33

4104. A photoconductivity apparatus. I. General circuitry. II. Measurement of transient photocurrents. L. E. Miller and F. A. Hamm. *Rev. sci. Instrum.*, **24**, 214–19 (*March*, 1953).

An instrument for the measurement of photocurrents is described. It has the advantage of an inherent time response of 0·1 sec with an accompanying sensitivity of $2{\cdot}0\times10^{-13}$ A per in. deflection on the oscillograph screen. These characteristics are shown to be desirable for the evaluation of transient photocurrents. A short discussion of the application of the instrument to the measurement of transient photocurrents in photographic emulsions is presented. These currents require 2 sec to reach a maximum amplitude for a variety of emulsions. Thus the process giving rise to these currents may be electrolytic rather than electronic. A.

537.312.6 : 536.48

4105. The electrical resistivity of gold at very low temperatures. A. J. Croft, E. A. Faulkner, J. Hatton and E. F. W. Seymour. *Phil. Mag.*, **44**, 289–96 (*March*, 1953).

The experiments were made (i) with a new apparatus in which a bath of liquid He can be cooled to 0·2°K and (ii) with a two-stage demagnetization apparatus in which temperatures of 0·006°K can be reached. The results showed that (i) for specimens in different states of physical strain down to 0·2°K and (ii) for a specimen down to 0·006°K the resistance is linear with log $1/T$. This is in constrast to the relationship to be expected from Slater's theory, i.e. R proportional to $\exp\theta/T$. A.

537.312.62

4106. An experimental and theoretical study of the relation between magnetic field and current in a superconductor. A. B. Pippard. *Proc. Roy. Soc. A*, **216**, 547–68 (*Feb.* 24, 1953).

The penetration depth, λ, in superconducting tin at 0°K has been found to be capable of variation by the addition of impurity, 3% of indium causing it to be nearly doubled, although the thermodynamical properties such as T_c are hardly affected. It is suggested that this result throws doubt on the phenomenological theory of F. and H. London, and a new equation for the supercurrent is proposed, in which the current is related to an average of the vector potential over a region around the point considered. The size of the region is governed by a parameter ξ, which is dependent, in a similar way to the mean free path in a normal metal, on the degree of purity. The new theory agrees in a satisfactory manner with the experimental results, and also provides an explanation of the magnitude of λ in a pure metal. It has been found that the unusual anisotropy of λ in pure tin is absent in tin + 3% indium, and this too is in agreement with the prediction of the new theory. The fact that the temperature variation of λ appears to have the same form independent of the degree of purity implies that ξ depends on temperature in the same way as λ; this result agrees with the observed behaviour of the interphase surface energy, α_{ns}, if ξ is regarded as determining the width of the interface between superconducting and normal regions. The paper ends with a discussion of the relation of the new theory to microscopic theories of superconductivity. A.

537.312.62

4107. Studies of compounds for superconductivity. W. T. Ziegler and R. A. Young. *Phys. Rev.*, **90**, 115–20 (*April* 1, 1953).

A number of metal carbides, borides, nitrides and a hydride, in the form of powders, have been examined for superconductivity down to 1·8°K using a magnetic method. The substances tested were TiC, VC, ZrG, TaC, WC, ZrB_2, NbB_2, TaB_2, WB, MoB, TiB_x, ThB_2, LaN, CeN, NbN and $LaH_{2\cdot45}$. All specimens were characterized by X-ray diffraction methods and, in most instances, by chemical analysis. Of these substances only NbN gave evidence of superconductivity. The results for NbN are in general agreement with the work of others. The results for TiC and VC are in agreement with those found by Meissner *et al.*, using an electrical resistance method, while those for TaB_2, NbB_2, WC and WB are in agreement with observations made by Matthias and Hulm using a magnetic method. On the other hand, ZrC, TaC, WC and "zirconium boride" had previously been observed to exhibit superconductivity above 1·8°K by the electrical resistance method. The results for WC and MoB have recently been confirmed by Matthias and Hulm. The substances ThB_2, LaN, CeN and $LaH_{2\cdot45}$ had not previously been examined for superconductivity. Particle size measurements were made on the carbide and boride powders. The particles were large enough for magnetic field penetration effects to have caused no difficulty, if a penetration depth of 1×10^{-5} cm, observed for pure metal, is assumed to apply to the present compounds. The failure to observe superconductivity in the substances ZrC, TaC, WC and MoB in the present study is discussed in terms of a postulated physical distribution of superconducting impurities of undetermined composition which are assumed to account for the superconductivity observed in these compounds by other investigators. A.

537.312.8

4108. The change of conductivity of metals in strong magnetic fields. Y. Tanabe. *Sci. Rep. Res. Insts Tôhoku Univ.* **3**, 91–106 (*Feb.*, 1951).

The change of resistance in a transverse magnetic field has been studied in strong magnetic fields up to 200 kilo-oersted at room temperature. The metals studied were Te, Ce, Sb, Fe, CO and Ni. It was found that there is a distinct difference in the change of resistance between the ordinary and the ferromagnetic metals. In the former case, the change of resistance follows the same law, which can be expressed by a formula giving a square law in weak fields and a linear law in stronger fields. In the latter case, the change of resistance abruptly decreases up to a field of magnetization saturation and then remains practically constant at stronger fields. The difference in the change of resistance between these two groups of metals was found by the fundamental difference in the origin of the conduction electrons. A.

537.312.9

4109. Increase of the resistivity of some face centered metals by cold-working. C. W. BERGHOUT. Letter in *Physica*, **18**, 978–9 (*Nov.*, 1952).

This has been measured for Cu, Au, Ag and Al wires, after annealing and drawing through dies, measurements being made at room temperature and at −190°c. The effect is independent of temperature for Cu and Al but not for Ag and Au.

M. R. HOPKINS

537.312.9 : 537.32

4110. On the changes of electrical properties in cold-worked metal. T. HIRONE AND K. ADACHI. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **3**, 454–8 (*Aug.*, 1951).

The increase in electrical resistance of metals due to cold work was discussed, taking into account the perturbing potential due to the edge dislocation caused by the said mechanical treatment. The method of calculating the electric conductivity was based on Peterson and Nordheim's assumption (1937) for the perturbing potential. An estimation of thermoelectric power due to cold work was made from the same point of view. A criticism was given for the theories by Koehler (1949) and MacKenzie–Sondheimer (1950). A somewhat smaller value was obtained than those quoted. A.

537.313

4111. The constant battery Wheatstone bridge. T. T. SMITH. *Amer. J. Phys.*, **21**, 247–9 (*April*, 1953).

Discusses the sensitivity of a constant battery Wheatstone bridge and shows that under certain conditions the bridge sensitivity will be independent of the magnitude of the resistance to be measured. A chart is given, which indicates for a given resistance the bridge ratio which provides the highest sensitivity. The bridge is insensitive for measuring resistances which are large in comparison with the resistance of the ratio arms. A.

537.321

4112. Thermoelectric effects in molybdenum disilicide. M. J. ARVIN. Letter in *J. appl. Phys.*, **24**, 498 (*April*, 1953).

Further evidence for the metallic nature of $MoSi_2$ is given; in particular, its thermal e.m.f. against Pt, in the temperature range −60°c to 600°c, is much the same as that of Cu against Pt. P. M. DAVIDSON

537.324 : 536.532

4113. On the theory of the thermocouple. J. E. VERSCHAFFELT. *Bull. Acad. Roy. Belgique Cl. Sci.*, **38**, 512–24 (1952) *In French.*

A new treatment based on the principle of superposition is compared with that of de Groot, based on Onsager's principle. The circuit discussed consists of wires of two different metals a source of e.m.f. being inserted in one wire. The new method is considered the more logical. E. H. DOCK

537.36

4114. On electrokinetics. J. E. VERSCHAFFELT. *Bull. Acad. Roy. Belgique Cl. Sci.*, **38**, *No.* 7, 685–92 (1952) *In French.*

Gives a theory of the flow of a charged dielectric along a tube in an electric field, and a critical analysis of treatments of the problem by other workers; also a summary of the author's theory of electrokinetic effects in ionized liquids [Abstr. 3552 (1952)] and a reply to some criticisms. P. M. DAVIDSON

537.364

4115. Dynamic potentials of freshly formed liquid surfaces. C. C. ADDISON AND D. LITHERLAND. Letter in *Nature* [*London*] **171**, 393–4 (*Feb.* 28, 1953).

The surface tension γ and the surface potential ΔV have been measured as a function of time for aqueous solutions of aliphatic alcohols. The final value of γ is reached in < 1 sec, i.e. as soon as concentration equilibrium has been established, and is almost independent of molecular orientation in the adsorbed layer (I); ΔV continues to change for periods of minutes, its initial value corresponding to "disorientation" and its final value to "orientation" in I. The term "surface potential" has no meaning without reference to the age and condition of the surface.

S. J. GREGG

ELECTRIC DISCHARGES 537.52

537.523.3

4116. Ions formed in a room by positive wire corona. H. NORINDER AND R. SIKSNA. *Ark. Fys.*, **6**, *Paper* 25, 255–61 (1953).

Describes measurements of ion densities and ion mobilities in the neighbourhood of a positive wire corona, during and after the establishment of the discharge. Israël and Ebert ion counters were used and time variations of ion densities could be made for specified mobility groups. Measurements were taken for periods varying up to 90 minutes after the discharge was switched off. Maximum ion densities were ~ 50 000/c.c. J. D. CRAGGS

537.523.5

4117. On mechanisms of mercury vapour arc discharge. I. Reactive character of mercury arc. S. KIMURA. *J. Phys. Soc. Japan*, **8**, 193–9 (*March–April*, 1953).

By applying an impulsive voltage to the anode of a glass mercury arc rectifier wherein the cathode spot exists, the wave forms of anode voltage, anode current and excitation anode voltage, were observed through a high speed oscilloscope or a transient analyser. It was found that a mercury arc has a characteristic of reactance and it can be explained through the inertia of mercury ions. A.

537.523.5

4118. On mechanisms of mercury vapour arc discharge. II. Structure of mercury arc. S. KIMURA. *J. Phys. Soc. Japan*, **8**, 200–6 (*March–April*, 1953).

Research was carried out with movable probes, as a result of which the aspect of the distribution of potential, electron temperature, electron density, neutral molecule density and luminous appearance of discharge were made clear. These quantities were considered by dividing the phenomena into the anode fall, the positive column and the distribution of the mercury vapour density. A.

537.523.5

4119. On mechanisms of mercury vapour arc discharge. III. Some characters of mercury arc. S. KIMURA. *J. Phys. Soc. Japan*, **8**, 207–12 (*March–April*, 1953).

Various experiments on the condition of ignition, the arc voltage drop fluctuation due to the motion of the cathode spot, the arc paths caused by a baffle inserted in the arc space were performed. Characteristics depending upon the temperatures of some parts of the arc equipment were also studied. A.

537.525

4120. A study of the influence of a strong transverse magnetic field on an unconfined glow discharge in air at about 1 mm pressure. W. D. MCBEE. *Univ. Microfilms Publ. No.* 2619 (1951), 222 *pp.* (Photoreproduction.)

Abstract in *Microfilm Abstracts*, **11**, *No.* 3, 626–7 (1951).

537.525.3

4121. Current increase at constant amplification factor in steady corona with coaxial cylindrical geometry. L. B. LOEB. *Phys. Rev.*, **90**, 144–6 (*April* 1, 1953).

It has long been known that above onset of steady positive wire corona with coaxial cylindrical geometry, Townsend's relation of 1914 relating current i and over-voltage, $V - Vg$, of the form $V - Vg = Bi/V$ applies over a considerable range. This law is deduced assuming a constant potential across a zone of limited constant ionizing radius. Such assumption implies a constant Townsend amplification factor for ionization by collision, a fact just recently experimentally established by Colli, Facchini and Gatti. The corona current i on this theory, however, increases many times despite constant amplification factor. It is shown that this occurs by slight temporary raising of the amplification factor producing a rapid proliferation of ionizing sequences over the anode surface, increasing current and space charge density, but maintaining essentially constant amplification factor. This action has a bearing on the spread of the normal glow discharge over the cathode. A.

537.525.3 : 537.525.72/.8

4122. The "corona pressure" and negative Joshi effect. H. J. ARNIKAR. Letter in *Proc. Phys. Soc.* [*London*] *B*, **66**, 256–8 (*March*, 1953).

Gives measurements of tube pressure in an ozonizer discharge, with and without external illumination, especially for the case of pure hydrogen. The results support the suggestion that a fall in discharge current, or irradiation, is associated with a decrease in the mobility of the ions responsible for the current flow.

J. D. CRAGGS

537.525.3 : 537.525.72 : 537.525.8

4123. Pulse behaviour in the production of negative Joshi effect in water vapour. N. A. RAMAIAH AND G. S. TIWARI. Letter in *J. sci. industr. Res.*, **11B**, 392–4 (*Sept.*, 1952).

Describes observations of ozonizer tube pulses at frequencies up to 30 Mc/s, and gives a qualitative discussion of possible mechanisms. J. D. CRAGGS

537.525.3 : 537.525.72 : 537.525.8

4124. Effect of heat on the frequency of the r.f. oscillations in a.c. silent discharges. S. R. KHASTGIR AND C. M. SRIVASTAVA. Letter in *Curr. Sci.*, **21**, 307 (*Nov.*, 1952).

It was found that the frequency of certain r.f. oscillations (~4 Mc/s) in ozonizer discharges through H_2, Cl_2 and I_2 decreased with increase of discharge tube temperature. The latter was ~30–50°C.

J. D. CRAGGS

537.525.3 : 537.525.72 : 537.525.8

4125. The formation of electrical double-layer on and near the glass surface in a.c. "silent" discharges. S. R. KHASTGIR AND P. S. V. SETTY. Letter in *Sci. and Culture*, **18**, 394 (*Feb.*, 1953).

Discusses possible mechanisms of the Joshi effect in ozonizer tubes, with special reference to wall effects.

J. D. CRAGGS

537.525.5 : 537.523.5

4126. The spectrum of an argon-nitrogen mixture excited in an high voltage arc. R. W. NICHOLLS. Letter in *J. chem. Phys.*, **21**, 568 (*March*, 1953).

Describes certain afterglows produced with high voltage a.c. discharges in A–N_2 (99·5% – 0·5%) at about 600 mm Hg pressure. Band spectra of N_2, i.e. the first and second positive systems, were observed.

J. D. CRAGGS

537.525.5 : 537.562 : 621.385

4127. Noise in gas discharges. A. VAN DER ZIEL. Letter in *J. appl. Phys.*, **24**, 223–4 (*Feb.*, 1953).

Briefly discusses the calculation of shot noise in a gaseous conduction current of electrons by consideration of the correlation between the pulses produced by a particular electron before and after a collision.

J. D. CRAGGS

537.525.72

4128. A new electron multiplication process. W. L. HARRIES AND A. VON ENGEL. Letter in *Nature* [*London*] **171**, 517 (*March* 21, 1953).

Since the peak h.f. breakdown field X in neon at pressures $p > 50$ mm Hg and frequencies $f \leqslant 10^7$ c/s corresponds to $X/p = 0{\cdot}6$ V/cm/mm Hg, ionization of the gas by electron collision is neglected. The electron avalanche growth is, therefore, considered to be due to photoelectric emission from the walls of the tube by photons produced by electron excitation of the gas followed by step-wise ionization of the gas by electron collision. F. LLEWELLYN JONES

537.525.72 : 537.525.8

4129. Ozonizer discharge. M. B. DESHMUKH. *J. Univ. Bombay*, **21**, 8–10 (*Nov.*, 1952).

Briefly describes the photographic recording of Joshi-effect pulses during one a.c. cycle in a Siemens ozonizer. J. D. CRAGGS

X-RAYS 537.531

537.531 : 535.313

4130. Construction of pseudo-spherical concave mirrors to give enlarged images with X-rays. J. DESPUJOLS. *C.R. Acad. Sci.* [*Paris*] **236**, 282–4 (*Jan.* 19, 1953) *In French.*

An aluminium single crystal with double curvature

was prepared [see Abstr. 1254 (1953)] giving effectively a mirror of 100 mm radius of curvature. A photograph of a wire gauze (×3) was obtained in 10 min. Aberrations and limits of magnification are discussed. A. R. STOKES

537.531 : 535.33

4131. The *L* spectra of nickel and copper. Y. CAUCHOIS. *Phil. Mag.*, **44**, 173–86 (*Feb.*, 1953).

An experimental investigation has been made of the *L* spectra of Ni and Cu, with a view to obtaining information about the distribution of the 3*d*, 4*s* and 4*p* states in these metals, and also the processes of X-ray emission and absorption. As already known, the *L* emission bands of Ni and Cu show striking differences. The Cu band observed is somewhat different from the one reported by Farineau; it is in good agreement with that to be expected from Mott's views on the behaviour of the electrons in this metal. The *L* absorption spectra of Cu and Ni were obtained for the first time; they help in interpreting the emission spectra. Some discussions are given of the present results in connection with former experimental and theoretical results from other authors. It is shown that the *L* spectra here obtained are consistent with the colour of Ni and Cu. Mention is made of a similar agreement in the case of Ag. A.

537.531 : 535.343

4132. Semi-empirical equations for the spectral energy distribution in X-ray beams. C. R. EMIGH AND L. R. MEGILL. *Non-destr. Test.*, **11**, 30–3 (*Jan.*, 1953).

The absorption in Al of X-radiation from a Be-window tube is studied. Schematic diagrams of the experimental set-up, which uses a NaI crystal and photomultiplier as detector, are given. Absorption data obtained are analysed using a Laplace transformation, and equations for the energy distribution from this X-ray set are deduced for 37 and 50 kV to an estimated accuracy of 5% of the maximum value. D. V. MABBS

537.531 : 535.43

4133. The optical principles of the low angle scattering of X-rays. N. N. GUPTA. *Proc. Nat. Inst. Sci. India A*, **18**, 379–88 (*Sept.–Oct.*, 1952).

Formulae for the intensity of scattering at low angles are worked out for non-absorbing spheres and for circular plates. A. R. STOKES

CATHODE RAYS . POSITIVE RAYS 537.533/.534

537.533

4134. The characteristics of the synchrotron beam. M. CAMAC. *Rev. sci. Instrum.*, **24**, 290–7 (*April*, 1953).

Measurements were made on the characteristics of the synchrotron electron beam at the time of the target irradiation. The orbit of the beam expanded from its synchronous accelerating orbit and irradiated individually a variety of Cu targets. There were two sets of measurements. In the first the bremsstrahlung beam intensity was measured. From these data the average number of beam traversals of each target was calculated. In the second set the target was removed from the vacuum system after a bombardment and cut into sections. The induced radioactivity of the individual pieces was measured. Information was obtained on the radial penetration of the target and the radial and vertical oscillations of the beam both before and after the target irradiation. The width of the synchrotron beam was 0·1 in. vertically and 0·14 in. radially. The radial penetration of the target by the primary beam decreased almost exponentially with the intensity dropping by a factor of 2 in about 0·0025 in. A.

537.533 : 621.384.62

4135. Travelling-wave linear accelerator for X-ray therapy. C. W. MILLER. *Nature* [*London*] **171**, 297–8 (*Feb.* 14, 1953).

Details are given of the design and performance of the linear accelerator at Hammersmith Hospital. The 3 m corrugated waveguide accelerator tube is fed with 2 μsec pulses from a 10 cm magnetron giving 2 MW peak power. The normal pulse recurrence frequency is 500 but up to 700 pulses/sec have been used with a maximum output of 1250 r/min at 1 m, the peak electron energy being a little below 8 MeV. Deviations from the design expectations following the theory of Walkinshaw (1948) are qualitatively explained. J. H. FREMLIN

537.533.72

4136. The derivation of paraxial constants of electron lenses from an integral equation. H. BREMMER. *Appl. sci. Res. B*, **2**, *No.* 6, 416–28 (1952).

The Liouville–Neumann expansions of the solutions of this equation lead to expressions for the magnification, the focal distances and the positions of the focal points and cardinal points. The numbers of integrations to be performed in the individual terms of the expansions used to describe lens characteristics are reduced to half, as compared with the normal treatment. The focal and cardinal points are defined as osculating elements similar to those introduced by Glaser (1950). A.

537.533.72

4137. An electrostatic lens permitting rigorous calculation. P. SCHISKE. Letter in *Nature* [*London*] **171**, 443–4 (*March* 7, 1953).

A lens for which $\Phi(z) = \Phi_0 - \Phi_0 x^2/[1 + (z/a)^2]$, $0 < x^2 \leqslant 1$ (the electrostatic equivalent of a solvable magnetic lens) can be calculated rigorously. The equation for the trajectories is given. G. D. SIMS

537.533.72

4138. A method for the measuring of low energy β-ray spectra. T. NOVAKOV. *Receuil Trav. Inst. Rech. Struct. Matière* [*Belgrade*] **1**, 1–4 (*July*, 1952).

A short magnetic lens spectrometer, of resolving power 3·5% determined by the ThB *F*-line, and a thin-mica-window G.M. counter with cut-off at 30 keV were used. The electrons were pre-accelerated in a spherically symmetric electric field between the source and the grid (at zero potential). Experiments were performed with ThB and RaE. The accelerated and unaccelerated spectra and lines did not differ but at low energies the resolving power decreased with pre-acceleration. S. WEINTROUB

537.533.74

4139. The scattering of slow electrons by the diatomic molecules. I. General theory. S. NAGAHARA. *J. Phys. Soc. Japan*, **8**, 165–8 (*March–April*, 1953).

A general theory of the scattering of slow electrons by diatomic molecules is formulated. The ellipsoidal coordinates are used, but the separability of the wave equation in these coordinates is not assumed. Explicit expressions for differential and total cross-sections are given, but the numerical evaluation is reserved for a later paper. A.

537.533.74

4140. The Oppenheimer approximation for the scattering of electrons. E. CORINALDESI, L. TRAINOR AND T.-Y. WU. Letter in *Nuovo Cimento*, **9**, 436–9 (*May*, 1952).

The "prior" and "past" matrix elements for the scattering of electrons by H and He atoms are derived in a way which shows that they are similar but not identical. W. J. SWIATECKI

537.533.74 : 537.534.74 : 537.512.2

Calculation of peaked angular distributions from Legendre polynomial expansions and an application to the multiple scattering of charged particles. *See Abstr.* 3783

537.533.74 : 539.132

Excitation of molecular rotation-vibration by electron impact. *See Abstr.* 4255

537.533.8

4141. On the polarization of high energy bremsstrahlung. K. PHILLIPS. *Phil. Mag.*, **44**, 169–72 (*Feb.*, 1953).

An attempt has been made to determine whether the bremsstrahlung from a 20 MeV betatron is polarized. The experiment consists essentially of measuring the angular distribution, with respect to the plane of emission of the photons, of photo-protons produced in the photodisintegration of the deuteron. The distribution instead of being purely symmetrical, as would be expected for unpolarized bremsstrahlung, indicates some asymmetry. A.

537.533.8

4142. Energy loss and Čerenkov radiation of a relativistic ionizing particle. P. BUDINI. Letter in *Phys. Rev.*, **89**, 1147–8 (*March* 1, 1953).

Formulae are derived according to which, as the kinetic energy of the particle becomes larger than its rest energy, an increase of both specific ionization and Cherenkov radiation should be expected in dense media, while in gases the Cherenkov radiation should become appreciable only at larger energies.

L. PINCHERLE

537.533.8

4143. The energy loss of a fast charged particle by Čerenkov radiation. R. M. STERNHEIMER. Letter in *Phys. Rev.*, **89**, 1148 (*March* 1, 1953).

A relativistic rise in Cherenkov radiation has not been observed in crystals or emulsions. It is pointed out that the refractive index has contributions from various absorption limits and that most of the radiation should occur at frequencies where the absorption coefficient is large: these effects are sufficient to explain why the radiated energy is small.

L. PINCHERLE

537.533.8

4144. Čerenkov radiation in a dispersive medium. H. MOTZ AND L. I. SCHIFF. *Amer. J. Phys.*, **21**, 258–9 (*April*, 1953).

Attention is called to the disagreement between a recent statement of Sommerfeld that the direction of propagation of Cherenkov radiation in a dispersive medium is determined by the group velocity, and the generally accepted result that the phase velocity must be used. The latter is shown to be correct, and the role of the group velocity is discussed in a way similar to that given in Tamm's 1939 paper on the theory of the Cherenkov radiation. A.

537.534

4145. A focusing method for large accelerators. T. KITAGAKI. Letter in *Phys. Rev.*, **89**, 1161–2 (*March* 1, 1953).

The use of alternate guiding magnets (having $n \sim 0$) and focusing magnets (having n large) is proposed. The latter magnets, which may be of quadrupole or solenoid construction and of relatively short length, are placed in the linear portions of the orbit. J. J. WILKINS

537.534 : 621.384.6

4146. Elementary theory of accelerators. Č. ŠIMÁNĚ. *Elektrotech. Obzor*, **41**, *No.* 8, 362–70 (1952) *In Czech.*

The elementary theory of accelerators is described on the basis of the Hamilton equations of the motion of charged particles in an electromagnetic field. Since classical mechanics are inadequate for the purpose, the relativistic mechanics required for investigation of the conditions in linear and circular accelerators are included. The theories of the linear electrostatic and the linear h.f. accelerator are described paying particular attention to the problems of space and phase stability of the particles.

E. GROS (R)

537.534 : 621.384.6

4147. A heavy-particle accelerator. J. W. GALLOP. Letter in *Nature* [*London*] **171**, 306–7 (*Feb.* 14, 1953).

A method of focusing the particles in a helical-wire travelling-wave accelerator is described. The helical waveguide is itself bent into a spiral, with an appropriate magnetic field. A considerable magnetic field gradient ($n \sim 1$) makes possible simultaneous radial, vertical and phase-focusing over a satisfactory range of phase. J. H. FREMLIN

537.534 : 621.384.62

4148. A new focusing principle applied to the proton linear accelerator. J. S. BELL. Letter in *Nature* [*London*], **171**, 167–8 (*Jan.* 24, 1953).

A system of focusing is described which could be applied to a linear accelerator consisting of a series of accelerating gaps separated by drift tubes free of r.f. field, such as the 30 MeV Berkeley machine. Each drift tube may be split longitudinally into four quadrants charged alternately to a few kV positive and negative, thus focusing particles in one plane and defocusing them in the plane at right angles. By varying the azimuth of the focusing field in successive tubes, a net focusing field can be obtained. A similar magnetic method is also described. J. H. FREMLIN (R)

537.534.74

4149. The multiple scattering of protons in thin foils. D. M. Skyrme. *Phil. Mag.*, **44**, 191–203 (*Feb.*, 1953).

The multiple scattering of 147 MeV protons in thin foils has been investigated using Pt, Ag and photographic emulsion as the scattering materials. The projected mean scattering angles, and the shape of the projected angular scattering distributions agree with the multiple scattering theory of Williams as modified by Voyvodic and Pickup. A.

537.534.74

4150. Neutron-proton scattering using organic crystal scintillation detectors. M. E. Remley, W. K. Jentschke and P. G. Kruger. *Phys. Rev.*, **89**, 1194–8 (*March* 15, 1953).

The angular distribution of protons recoiling from neutrons of 13·7 MeV and 28·4 MeV has been investigated in the region of 0° to 90° in the centre-of-mass system. Organic scintillation crystals of anthracene and stilbene were used as both sources and detectors of the recoil protons. The angular distribution observed at 13·7 MeV is consistent with spherically symmetric scattering, while the results at 28·4 MeV show an anisotropy with a favouring of scattering of the neutrons in the backward direction. A.

537.534.74

4151. Elastic scattering and neutralization of low velocity hydrogen ions in methforane and ethforane. J. H. Simons and C. S. Garber. *J. chem. Phys.*, **21**, 689–92 (*April*, 1953).

The low velocity scattering of H^+, H_2^+ and H_3^+ in both methforane and ethforane has been measured at ion velocities of less than 150 V. Ion neutralization was detected and measured for all three ions in both fluorocarbons and elastic scattering potential functions evaluated for all six interactions. These measurements are compared with similar ones made on the hydrocarbons methane and ethane. A.

537.534.74

4152. Modern mass spectrometry. G. P. Barnard. *London: Institute of Physics* (1953) 324 *pp.*

The main purpose is to collect together and critically discuss the substantial body of knowledge and technique about the mass spectrometer and its uses in most branches of pure and applied science. Introductory chapter, which includes the general theory of the instrument. Chapters on ion sources, vacuum techniques and gas-flow problems cognate to mass spectrometry, collection and measurement of ion beams and associated electronic devices. Some existing research and industrial instruments are described. Five chapters (115 pages) are devoted to applications in physics, chemistry and engineering, to hydrocarbon analysis, to studies of molecular structure and chemical kinetics, to applications of isotopic tracer techniques to biochemistry and to isotopic studies in geology and nuclear chemistry. List of some 400 references. Appendix on the mass spectrometry laboratory, including some remarks on the staff required.

537.534.75

4153. Mean excitation potentials. D. C. Sachs and J. R. Richardson. *Phys. Rev.*, **89**, 1163–4 (*March* 15, 1953).

Previous experimental results of the present authors on the energy loss of 18 MeV protons in Al are corrected to give a value for the mean excitation potential $I = 168$ eV. It is pointed out that recent work on the range-energy relationship for protons in Al may indicate a variation of I with proton energy which is considerably larger than that to be attributed to the nonparticipation of the K electrons. A.

DISCHARGE TUBES . COUNTERS 537.54

537.542 : 778.33

Indirect autoradiography with a scintillation counter. *See Abstr.* 4547

537.542

4154. The efficiency of an immersion counter for measuring beta and gamma emitters in solution. G. N. Walton. *Physica*, **18**, 1280–6 (*Dec.*, 1952).

Measurements are reported of the counting efficiency (counts/disintegration/ml) of a glass G.M. tube immersed centrally in cylindrical vessels of varying diameter containing solutions of a range of β emitters and $\beta\gamma$ emitters. The effective thickness of the counter wall is estimated, and after allowing for this, a linear relationship is established between the β-counting rate from an infinite thickness of liquid, and the absorption half thickness of the β activity measured. The effective wall thickness is also found for the β activity from very thin layers of liquid. The efficiency for counting hard γ activity from thick layers is shown to be proportional approximately to the total photon energy released per disintegration. A.

537.542

4155. Pulsed G-M tube operation. S. W. Lichtman. *Nucleonics*, **11**, 22–7 (*Jan.*, 1953).

Two methods, enabling G.M. tubes to be operated in very strong radiation fields without blocking, are described. In the first method, the tube is operated with a sufficient d.c. potential to place it on the G.M. plateau, and voltage pulses of some hundreds of volts height and a few microseconds width, at a regular repetition rate, are superimposed. The whole of the high voltage to the tube is applied in short periodic pulses, in the second case. The tube performance, in particular the extension of range of the measurable radiation intensities, in both methods, is discussed, both with regard to counting rate and average tube current. The range extension is shown to depend on the ratio of tube dead time to pulse width. It is possible to use very large overvoltages in pulse operation and under these conditions the tube current and pulse size become largely independent of the applied potential. This eliminates the need for voltage stabilization. L. R. Shepherd

537.542

4156. Low voltage counter tubes. P. Kunze and G. Schulz. *Ann. Phys.* [*Leipzig*] **11**, *No.* 4–7, 225–38 (1953) *In German.*

The paper commences with a discussion of the physics of gaseous mixtures which break down at abnormally low voltages (e.g. Penning mixtures o

Ne–A) and proceeds to describe expts. with He–A, A–Hg mixtures, etc., in Geiger counters. He–Ne–A was also studied and gave a minimum breakdown voltage of about 170 V; in the other mixtures values of about 250 V were obtained. The data are given in graphical form in some detail. J. D. CRAGGS

537.542

4157. A large-window rectangular β Geiger Mueller counter. A. M. MILOJEVIĆ. *Receuil Trav. Inst. Struct. Matière* [*Belgrade*] **1**, 11–16 (*July*, 1952).

Details of the construction and properties are given. The Al foil window is 132×13 mm and 40 μ thick. The counter was constructed to be fitted in the side of an automatic cloud chamber. Best results were obtained with an ether-argon filling for which the plateau was 175 V approximately with a slope of 0·03% per volt. The characteristics were similar to those of cylindrical counters, but the plateau lengths were shorter. The effective length of the counter was about 75% of the total length. The relative sensitivity to γ rays was studied. S. WEINTROUB

537.542

4158. Tri-α-naphthylborine, a new scintillation material for thermal neutrons. J. J. VAN ZOLINGEN AND J. J. WENT. Letter in *Physica*, **18**, 976–7 (*Nov.*, 1952).

537.542

4159. A high-resolution detector for high-intensity radiation. W. C. HALL, B. M. HORTON, J. W. KELLER AND S. H. LIEBSON. *Nucleonics*, **11**, 49–55 (*Jan.*, 1953).

The detector consists of a coaxial phototube with a central cathode, surrounded by a cylindrical mesh anode. The tube is enclosed in a cylindrical sleeve containing a scintillating material (terphenyl in toluene was used). Expressions, relating the light received at the cathode, the output currents and voltages, to the light generated in the sleeve and the geometric parameters, are derived. The characteristics of the phototube are described. The detector has a resolving time of about 2×10^{-9} sec.

L. R. SHEPHERD

537.542

4160. Some comments on the resolution of scintillation spectrometers. P. W. ROBERTS. Letter in *Proc. Phys. Soc.* [*London*] *A*, **66**, 192–4 (*Feb.*, 1953).

An expression is given for the variance of the pulse distribution from a scintillation counter in terms of the variances in the distributions of the scintillations from the crystal, in the secondary electrons from the first dynode and separately from the remainder of the multiplying dynodes. Estimates are made of the resolution of the counter when used as an energy spectrometer, the results of several different workers being compared. G. F. J. GARLICK

537.542 : 621.317.31 : 621.387.46

4161. A betatron monitor and integrator. R. D. ENGLAND AND W. E. OGLE. *Rev. sci. Instrum.*, **24**, 267–8 (*April*, 1953).

A monitor and integrator for use with a betatron are described. Both instruments are based on scintillation type detectors, using 931-A photomultipliers. The monitor presents the filtered output current of the photomultiplier directly on a microammeter. The integrator charges a capacitor with the output of the photomultiplier, fires a thyratron at a pre-set voltage level, then recycles. Difficulties in eliminating leakage currents and obtaining a linear response in the integrator are described. A.

537.542 : 621.387.46

4162. A method of increasing the effective resolution of scintillation counters. K. G. STANDING AND R. W. PEELLE. *Rev. sci. Instrum.*, **24**, 193–5 (*March*, 1953).

A system consisting of two photomultipliers viewing one scintillating crystal is given for resolving peaks in a scintillation spectrum which otherwise would overlap because of photomultiplier statistics. A differential discriminator accepts pulses from a fixed portion of the spectrum from one of the tubes. Another differential discriminator scans the spectrum from the second tube and is coincidence gated by the first. Experimental results are presented which show that this method can separate monoenergetic lines not otherwise resolved. A.

537.542

4163. The use of scintillation detectors for measuring ultra-short time intervals. A. LUNDBY. *Arch. Math. Naturvid. B*, **51**, *No.* 6, 91–116 (1952).

Anthracene crystals in conjunction with 1P21 photomultipliers have been used in a delayed coincidence circuit with a resolving time of the order of 10^{-9} sec. A search for metastable states in Zr^{95}, Mo^{99}, $Sb^{122,124}$, Cs^{134}, Ta^{182} and Au^{198} gave negative results. The shapes of the pulses from the scintillation counters have been studied. The most satisfactory procedure for obtaining a high resolving power appears to be first to integrate the current from the multipliers over a time of the order of the decay period of the phosphor and then to cut the pulse off with a shorted delay line. The fluctuations in the rise time of the output pulses due to single electrons released from the cathode set the lower limit of the time intervals which can be measured to a few times 10^{-10} sec. A.

537.542

4164. On the detection of high energy particles with a fast coincidence system. K. STRAUCH. *Rev. sci. Instrum.*, **24**, 283–9 (*April*, 1953).

A coincidence system is described that includes a fast diode bridge coincidence circuit of the type used by Neher. A discussion is given of the properties of such a system that are desired for its use in the detection of particles with a continuous energy spectrum. The adjustment and testing of the system for a given experiment are considered in detail. Finally, the performance of a proton telescope utilizing five fast coincidence channels is described. A.

537.542 : 621.318.572

4165. A new pulse-analyzer design. C. W. JOHNSTONE. *Nucleonics*, **11**, 36–41 (*Jan.*, 1953).

The analyser described employs a window amplifier with a gain of about 10 followed by 1, 6, 10 or 18 sorting channels. The channel circuits utilize 6BN6 tubes as trigger amplifiers, suitably biased to define the channel boundaries, followed by bootstrap-type univibrators. In the multichannel circuits, anticoincidence mixing of negative output pulses from the univibrators of successive channels is used to secure

single channel recording. The channel widths at input are as low as 1 V and stable to ±2%. Pulses with rise times ranging from a fraction of a microsecond up to about 10 μsec can be accepted.

L. R. SHEPHERD

537.542 : 621.318.572

4166. Applications of kicksorters. G. W. HUTCHINSON. *Nucleonics*, **11**, 24–7 (*Feb.*, 1953).

From a brief consideration of the energy resolution of detectors such as proportional counters used in pulse-height analysis, it is concluded that the stability of scale zero, or the constant of proportionality in kicksorters need not be much better than 1%, but the relative channel widths should be as small as possible. The type of kicksorter using voltage to time conversion, and a sonic delay line storage system, is discussed briefly. Some uses of kicksorters in coincidence experiments, including a method of delayed coincidence measurement, are reviewed.

L. R. SHEPHERD

537.542 : 621.387.464 : 621.311.6

4167. A scintillation-counter power supply offering long-time stability. A. B. SPERRY. *Nucleonics*, **11**, 61–3 (*Feb.*, 1953).

The unit described provides stabilized supplies of 1600 V, 300 V and −105 V d.c. and 6·3 V a.c. It contains also, a high-stability Schmitt-type discriminator built into the set. The 1600 V supply is of the r.f. type, using a 200 kc/s oscillator. Stabilization is provided, by feedback from the 1600 V output to the screen of the oscillator tube. The net change observed in this output over a period of 22 hr was only 1·3 V.

L. R. SHEPHERD

537.542 : 621.318.572

4168. Gated decade counter requires no feedback. E. L. KEMP. *Electronics*, **26**, 145–7 (*Feb.*, 1953).

The basic decade is formed by 3 binary stages in cascade; the gate between the first two stages is closed by the 8th pulse and reopened by the 10th, through a control circuit which is fed from the 1st and 3rd stage; this control circuit resets the 2nd and 3rd stage and supplies the carry pulse. The complete circuit has a resolution time of 2 μs; it is fully illustrated.

T. J. REY (R)

537.542 : 519.24

4169. The statistical significance of counts differing only slightly from the mean background level. D. J. BEHRENS. *Atomic Energy Res. Establ.* [*Harwell*] *Rep. T/R*640, 4 *pp.* (1951).

It is shown that, when an activity gives rise to a count differing only slightly from the mean background, the statistical mean activity may be well above the excess of the count over the background. Quantitative tables are included.

A.

537.542

4170. Momentum determinations from cloud chamber photographs in axially symmetrical magnetic fields. A. M. CORMACK. Note in *Rev. sci. Instrum.*, **24**, 232 (*March*, 1953).

537.543 : 621.385.832

4171. Positive and negative ions in cathode-ray tubes. C. H. BACHMAN, G. L. HALL AND P. A. SILBERG. *J. appl. Phys.*, **24**, 427–33 (*April*, 1953).

The positive and negative ions accompanying the operation of a cathode-ray tube contribute in a number of ways to tube failure. These ions have been studied in standard sealed-off tubes. The identities of the most persistent ions have been determined and ion currents measured. Some attempts to limit or control the ions at their sources have been made. The greatest offender is hydrogen which is present as both negative and positive ions. It is shown that aluminized screens offer little protection to the ion bombarded phosphor. Uncertainty in the literature as to whether negative m/e, 26 is C_2H_2 or CN seems resolved in favour of C_2H_2.

A.

537.543 : 621.3.014.1 : 621.385

4172. Space charge limited currents between inclined plane electrodes. Approximate solutions. H. F. IVEY. Letter in *J. appl. Phys.*, **24**, 227 (*Feb.*, 1953).

Approximate expressions are obtained for two functions occurring in solutions previously given [see Abstr. 3663 (1952)] for current density between inclined plane electrodes.

M. R. HOPKINS

537.543 : 621.385.2/.3

4173. Low frequency noise in electron tubes. A. Space charge reduction of flicker effect. J. G. VAN WIJNGAARDEN AND K. M. VAN VLIET. *Physica*, **18**, 673–8 (*Oct.*, 1952).

The theory of the reduction of flicker noise by space charge in diodes and triodes is discussed and leads to the expression $I_{VF} = (kT/\sigma e i_0)^2 I_{0F}$, where I_{VF} = flicker noise current with space charge, I_{0F} = flicker noise current in temperature limitation, σ = ratio of equivalent diode conductance to triode g_m ($0{\cdot}5 < \sigma < 1{\cdot}0$) and the other symbols have their usual meanings.

A. H. W. BECK

537.543 : 621.385.3

4174. Low frequency noise in electron tubes. B. Measurements on triodes under normal operating conditions. J. G. VAN WIJNGAARDEN, K. M. VAN VLIET AND C. J. VAN LEEUWEN. *Physica*, **18**, 689–704 (*Oct.*, 1952).

For theory see A. The results were: (1) W cathodes. Flicker noise negligible above 10 c/s increases as f^{-1} below this frequency. (2) Thoriated W. Flicker noise varied as $i_0^2 f^{-1}$. (3) Oxide cathodes. Two distinct types of behaviour were observed. (3.1) Frequency variation as f^{-1}. These variations are thought to be due to variations in coating conductivity. (3.1) Frequency variation as $Af^{-1} + B(f^2 + \beta^2)^{-2}$ where A, B and β are constants. β can be related to the time during which an emission centre is active.

A. H. W. BECK

537.543 : 621.317.723 : 621.385.3

4175. Low frequency noise in electron tubes. C. Electron tubes. J. G. VAN WIJNGAARDEN AND E. F. DE HAAN. *Physica*, **18**, 705–13 (*Oct.*, 1952).

Several types of commercial electrometer were studied. All showed flicker noise varying as f^{-1} and some showed an additional effect varying as f^{-2} especially the 4060 Philips type. The noise observed with the grid floating agrees well with the calculated value resulting from the noise with short circuited grid and the measured grid current.

A. H. W. BECK

IONIZATION . THERMIONICS 537.56/.58

537.563

4176. Negative ion formation in gases of high dielectric strength. J. W. WARREN, J. MARRIOTT AND J. D. CRAGGS. *Nature* [*London*] **171,** 514–15 (*March* 21, 1953).

A brief discussion of collision processes, notably those giving negative ions, in certain polyatomic molecular gases (SF_6, CCl_2F_2, etc.). Some results for CCl_4 and SF_6 are shown graphically. J. D. CRAGGS

537.564

4177. Inelastic collisions between atoms. I. General theoretical considerations. D. R. BATES, H. S. W. MASSEY AND A. L. STEWART. *Proc. Roy. Soc. A,* **216,** 437–58 (*Feb.* 24, 1953).

The probability of slow inelastic collisions between two atomic systems is investigated theoretically using the perturbed stationary state method (p.s.s. method) in which the kinetic energy of the relative motion is treated as the perturbation responsible for the transitions. The p.s.s. method has been extended to include cases in which resonance degeneracy occurs and when the transition concerned involves a change of the axial component of angular momentum. The scope and limitations of the method are examined in detail and compared with those of Born's approximation. It is shown that two modifications of the latter approximation are of comparable importance in most cases, one involving a change in the effective transition potential, the other the distortion of the plane waves representing the relative motion of the colliding systems. The first of these is the only one included in previous applications. It is shown that, under semi-classical conditions, the formulae of the p.s.s. method reduce to Mott's impact parameter formulae provided the important distortion effect is neglected. New semi-classical formulae, including this effect as well as the effect of resonance degeneracy, are derived in a form suitable for numerical application. A.

537.565

4178. Motion of gaseous ions in strong electric fields. G. H. WANNIER. *Bell Syst. tech. J.,* **32,** 170–254 (*Jan.,* 1953).

This paper applies the Boltzmann method of gaseous kinetics to the problem of charged particles moving through a gas under the influence of a static, uniform electric field. The particle density is assumed to be vanishing low, and the ion-atom collisions are assumed elastic, but the field is taken to be strong; that is, the energy which it imparts to the charges is not assumed to be negligible in comparison to thermal energy. In Pt I, the formal framework of such a theory is built up; the motion in the field is describable by the drift velocity concept, and the smoothing out of density variations as an anisotropic diffusion process. In Pt II, the "high field" case is treated in detail; i.e. the case for which thermal motion of the gas molecules is negligible; the equation is solved completely for the case that the mean free time between collisions may be treated as independent of speed; complete solutions are also presented for extreme mass ratios of the ions and the molecules; special attention is given to the case of equal masses, which has to be handled by numerical methods. In Pt III, information about the "intermediate field" case is collected; with the help of a convolution theorem the case of constant mean free time is solved; beyond this, only the case of small ion mass (electrons) is available. In Pt IV, the diffusion process, whose existence was proved in Pt I, is pushed through to numerical results. Pt V discusses the scope of the results achieved and demonstrates the possibility of extending them semiquantitatively beyond their original range. A.

537.581

4179. Work functions of gas-coated tungsten and silver surfaces. G. L. WEISSLER AND T. N. WILSON. *J. appl. Phys.,* **24,** 472–5 (*April,* 1953).

The average electronic work functions of tungsten and silver surfaces, subjected to glow discharges in various gases (He, A, H, N, O_2, Freon-12) and to water vapour, have been determined by Oatley's magnetron contact potential method. Oxygen and Freon-12 produced increases in work functions in excess of 1 eV, whereas nitrogen and particularly hydrogen caused decreases of the order of 0·5 eV. The inert gases and water vapour produced relatively little changes. The history and treatment of the surfaces is described, and the data presented have been found to be reproducible. A.

537.583 : 621.317.331 : 621.385.032.216

4180. A retarding potential method for measuring electrical conductivity of oxide-coated cathodes. I. L. SPARKS AND H. R. PHILIPP. *J. appl. Phys.,* **24,** 453–61 (*April,* 1953).

A retarding potential method is developed for measuring the electrical conductivity of normal oxide cathode coatings. The method is limited by normal current measuring devices and cannot be used for coatings which have a conductivity to thermionic emission ratio greater than 2 cm/volt. Advantages of the method are: (1) the conductivity of coatings which are in a normal state for thermionic emission may be measured without the use of probe wires or other devices which might impair the thermionic emission of the sample, and (2) conductivity and thermionic emission measurements may be made simultaneously on the same coating sample. The theory of the method is discussed in detail and experimental results obtained using this method on both BaO and (BaSr)O coatings are given. A.

537.583 : 621.385.032.21

4181. A survey of present knowledge of thermionic emitters. D. A. WRIGHT. *Proc. Instn Elect. Engrs, III,* **100,** 125–43 (*May,* 1953).

For abstract, see Abstr. 297 (1953).

COSMIC RAYS 537.591

537.591 : 523.51

4182. Meteorites as cosmic ray meters. S. F. SINGER. Letter in *Phys. Rev.,* **90,** 168 (*April* 1, 1953).

Meteorites can be considered as integrating cosmic ray meters which accumulate cosmic-ray-produced

stable He^3. In addition, the study of a radioactive species yields the recent cosmic ray intensity experienced by the meteorite. The amount of cosmic-ray-produced T in secular equilibrium is calculated to be $\sim 5 \times 10^6$ atoms/g of meteorite, giving $\sim 0{\cdot}01$ decays/sec. AUTHOR

537.591.1

4183. Effects of the atmosphere on the penetrating cosmic radiation. R. L. CHASSON. *Phys. Rev.*, **89**, 1255–6 (*March* 15, 1953).

A comparison is made of the results of three independent studies of upper-atmospheric influences on the penetrating cosmic radiation. The results of Cotton and Curtis are in disagreement with those of Duperier and the author, who agree very closely on the value of the upper-atmospheric temperature coefficient for the hard radiation observed at sea level. The work of Cotton and Curtis is examined with regard to method of data reduction, whereupon it is suggested that they are possibly in error because of statistical inadequacy of the cosmic-ray data and an improper mode of application of meteorological data. A.

537.591.1 : 539.17

High energy nuclear physics. *See Abstr.* 4337

537.591.1 : 551.594.21

4184. High energy particles from thunderstorms. J. CLAY, H. F. JONGEN, A. J. J. AARTS, B. JONGEJANS AND J. STRACKEE. *Proc. K. Ned. Akad. Wetensch. B*, **55**, *No.* 4, 300–2 (1952).

Records of the cosmic ray intensity measured by 5 independent ionization chambers and two counter sets in Amsterdam during a local thunderstorm show increases in intensity of up to 6%. One of the ionization chambers, shielded by 112 cm Fe, showed no increase. The increase in intensity is attributed to the production of electrons with energies up to 10^{10} eV in the thunder clouds. H. ELLIOT

537.591.15

4185. An experimental investigation of the nucleon cascade in water. C. B. A. MCCUSKER, H. MESSEL, D. D. MILLAR AND N. A. PORTER. *Phys. Rev.*, **89**, 1172–7 (*March* 15, 1953).

The nucleon cascade in water produced by primaries of energy greater than 20×10^9 eV has been examined using an array of G.M. counters and a 31-channel hodoscope. Over 15 000 showers have been studied. Transition curves for various primary energies, barometric coefficients for various multiplicities and at different depths, root mean square lateral spreads, and intensities at different depths are given. The experimental results are compared with the theory of the nucleon cascade developed by Messel and his co-workers [Abstr. 6609 (1952)]. In particular, the variation of lateral spread with depth substantiates their conclusion that the differential cross-section for nucleon-nucleon collision at high energies has a very peaked form in the forward direction. A.

537.591.15

4186. A search for penetrating showers from hydrogen at sea level using a cloud chamber. A. B. WEAVER. *Phys. Rev.*, **90**, 86–95 (*April* 1, 1953).

The extent to which multiple production of π-mesons takes place in local sea-level penetrating showers was studied with a counter controlled cloud chamber in a magnetic field. The rates at which penetrating showers occur under C, Al and Pb were determined and a search was made for them under liquid H. In a total operating time of 626 hours with an average thickness of $2{\cdot}28$ g/cm^2 of liquid H above the chamber, no penetrating showers were found which could have originated in the H. On the basis of the rates at which such showers occur in heavier materials and the number of them formed in the material of the Dewar while operating with H, one would have expected to detect a minimum of 6 showers from the H if the cross-section for the production of penetrating showers were the geometric area of the nucleus (taken as 6×10^{-26} cm^2 for H). It can then be concluded that the majority of sea-level local penetrating showers detected below heavy materials by an apparatus of this kind can be attributed mainly to plural production. From momentum measurements in the magnetic field, the minimum value which can be assigned to the momentum of the incident nucleons which causes the average penetrating shower detected with this apparatus was estimated at 6 BeV/c. It follows that the multiple production of charged mesons in a single nucleon-proton collision at about 6 BeV probably does not occur in more than 15% of the cases. The ratios of the rates at which penetrating showers were detected under C, Al and Pb were proportional to the geometric area of the nuclei within statistical limits. An event found in the H which is very similar in appearance to the μ-meson interaction first observed by Braddick and Hensby is discussed. A photograph of a nuclear collision in Pb is described in which very little energy is transferred to the Pb nucleus although the incident particle has a momentum estimated to be 40 BeV/c. A

537.591.

4187. The absorption of the hard component of cosmic rays in water. A. J. DYER. *Austral. J. Phys.*, **6** 60–6 (*March*, 1953).

The differential and integral range spectra of the hard component of cosmic rays in water have been measured down to a depth of $18{\cdot}3$ m of water, and the integral results confirm the work of Ehmert (1937) and Wilson (1938) in this region. A lack of statistical accuracy in the differential measurements prevents the possible observation of an anomaly corresponding to $2{\cdot}5$ BeV/c momentum. A comparison of the range and momentum spectra on the basis of the energy loss data of Halpern and Hall shows satisfactory agreement. The absolute value of the differential intensity is found to be 20% higher than that given by Rossi [Abstr. 1964 (1949)] but agrees with the more recent result of York [Abstr. 4443 (1952)]. A

537.591.

4188. Seasonal variation of large cosmic-ray bursts T. KAMEDA AND M. WADA. *Progr. theor. Phys.*, **7** 586–8 (*May–June*, 1952).

The seasonal variation of large bursts ($>13{\cdot}4 \times 10$ ion pairs) at sea level and under 170 g/cm^2 of concrete at Tokyo is compared with that at Chelten ham, U.S.A. There is good agreement between the three sets of data and the variation appears to have an amplitude of $\sim 5\%$, maximum frequency occurring in winter. The burst frequency has been correlate

with atmospheric temperature at sea level and this leads to a temperature coefficient of $\sim -1\%$ per °C for each set of data. H. ELLIOT

537.591.5

4189. Latitude effect and asymmetry of cosmic radiation. J. CLAY AND J. STRACKEE. *Proc. K. Ned. Akad. Wetensch. B*, **55**, *No.* 4, 310–16 (1952).

The latitude effect at sea level has been measured between Amsterdam and the equator using both shielded and unshielded ionization chambers and counter sets. The latitude variation for the soft component has been calculated by taking the difference in intensities as measured by the shielded and unshielded sets and is found to be ~50% compared with from 10 to 15% for the penetrating radiation and the total intensity. Some observations on the longitude effect are also given together with the results of measurements on the asymmetry of the radiation at an altitude of 2880 m near the equator. H. ELLIOT

537.591.5

4190. Daily variation of meson intensity and its possible solar origin. V. SARABHAI, U. D. DESAI AND R. P. KANE. Letter in *Nature* [*London*] **171**, 122–3 (*Jan.* 17, 1953).

The solar daily variation for mesons penetrating 11 cm Pb has been measured at Ahmedabad (mag. lat. 13°N, altitude 50 m) and at Kodaikanal (mag. lat. 1°N, altitude 2343 m). The variation at each station, after correcting for barometric pressure, is predominantly diurnal. The amplitude at Kodaikanal is 1·1% with time of maximum at 08.40 hr local time whereas at Ahmedabad the amplitude is 0·33% and the time of maximum 09.50 hr local time. The variation is attributed to cosmic rays produced by the sun. H. ELLIOT

537.591.5

4191. Cosmic-ray neutron production in elements as a function of latitude and altitude. J. A. SIMPSON AND R. B. URETZ. *Phys. Rev.*, **90**, 44–50 (*April* 1, 1953).

The relative rates of local neutron production in Al, Cu, Sn and Pb were obtained at geomagnetic latitudes $\lambda = 40°$ and 54° at atmospheric depth 312 g.cm^{-2} (30 000 ft pressure altitude). The latitude and altitude dependence of local neutron production in C and Pb were measured in the latitude interval 0°–54° with pile geometries containing BF_3 proportional counters. From these observations several results were obtained: 1. The relative neutron multiplicities in elements were measured and found to be in good agreement with reported low altitude observations. 2. A neutron transition maximum in Pb at ~20 g.cm^{-2} Pb was obtained at 33 000 ft pressure altitude. 3. The absorption mean free path for the neutron-producing radiation in Pb was 350 g.cm^{-2}. 4. An anomalous air absorption mean free path for the nucleonic component has been found for measurements derived from local neutron production in Pb at $\lambda \gtrsim 40°$. 5. Aside from the absorption anomaly in elements of high atomic weight A, local neutron production in elements of high A as a function of λ is in fair agreement with the free air neutron latitude effect. 6. Local production in C as a function of λ and altitude is in agreement with corresponding free air neutron measurements. A.

537.591.5 : 523.72

4192. World-wide effects of continuous emission of cosmic rays from the sun. V. SARABHAI AND R. P. KANE. *Phys. Rev.*, **90**, 204–6 (*April* 15, 1953).

The Carnegie Institution barometric pressure-corrected cosmic-ray meson intensity data for solar time daily variation at Huancayo, Cheltenham and Christchurch have been harmonically analysed. Time-series covering the period 1937 to 1946 have been derived for variations of the amplitude and hour of maximum of the meson diurnal variation. These reveal that the amplitude and hour of maximum undergo large long-term world-wide changes. The time-series for mean of the diurnal amplitude observed at the three stations has high positive partial correlations with relative sunspot number and American magnetic character figure. The correlations are higher during years of low sunspot activity. The new evidence confirms earlier experimental findings of the authors indicating that the barometric pressure-corrected meson intensity diurnal variation is caused by an anisotropy of the primary cosmic rays connected with the emission of high-energy charged particles from the sun. In addition it reveals that the sun is a continuous source of cosmic radiation, the activity of emission varying broadly in step with the solar cycle. A.

537.591.8

4193. High-energy particles. B. ROSSI. *New York: Prentice-Hall* (1952) 569 *pp.*

Review in *J. Franklin Inst.*, **255**, 78 (*Jan.*, 1953).

537.591.8

4194. On the interaction of cosmic rays with matter under 50 meters water equivalent. E. AMALDI, C. CASTAGNOLI, A. GIGLI AND S. SCIUTI. *Nuovo Cimento*, **9**, 453–5 (*May*, 1952).

A counter hodoscope set was used to investigate the production cross-section for pairs of penetrating particles in lead as a function of the range of the secondary particle. The values obtained for particles which penetrate 57, 113 and 170 gm cm^{-2} Pb are (6 ± 1), (5 ± 1) and $(2 \pm 1) \times 10^{-30}$ cm^2/nucleon respectively. H. ELLIOT

537.591.8

4195. The transition effect of star production. H. KOMORI. Letter in *Progr. theor. Phys.*, **8**, 134–6 (*July*, 1952).

Estimates the contribution to star production under an absorber by photons, slow protons and backward scattered nucleons. H. ELLIOT

537.591.8

4196. The use of neutron counters to obtain cloud-chamber photographs of *V*-particle decays. K. H. BARKER, R. D. SARD AND M. G. SOWERBY. *Phil. Mag.*, **44**, 46–50 (*Jan.*, 1953).

In an attempt to increase the rate at which cloud-chamber photographs of *V*-particle decays can be obtained a number of triggering arrangements incorporating BF_3 neutron counters have been used on the Pic-du-Midi (2867 m). The yields of *V*-particle decays are found to be comparable with the yield of a typical multiple Geiger counter system. A.

537.591.8

4197. Note on the fluctuation problem of cascades. L. JÁNOSSY. Letter in *Proc. Phys. Soc.* [*London*] *A*, **66**, 117–18 (*Jan.*, 1953).

An error in a previous paper [Abstr. 4336 (1950)] is corrected and it is shown that the original conclusions remain unchanged. H. ELLIOT

537.591.8

4198. On the nuclear interactions of cosmic ray shower particles in lead. I. KITA AND O. MINAKAWA. *J. Phys. Soc. Japan*, **8**, 139–41 (*March–April*, 1953).

Using a counter-controlled cloud chamber in conjunction with a hodoscope, nuclear interactions caused by secondary shower particles were investigated and classified as high- and low-energy showers by the inspection of hodoscope pictures. The results show that the multiplicities of the low and high energy secondary showers are $2{\cdot}8 \pm 0{\cdot}4$ and $3{\cdot}1 \pm 0{\cdot}4$ respectively, and, from angular distributions of tertiary particles, it is concluded that the mesons are presumably produced multiply and isotropically in the C-system. A.

MAGNETISM 538

538.113

4199. The diamagnetism of an enclosed electron gas. H. A. NYE. Letter in *Phys. Rev.*, **89**, 1305–6 (*March* 15, 1953).

Discusses the effects of surface states on the diamagnetism of a free electron gas enclosed in a finite container [see also Abstr. 949–50 (1953)]. E. P. WOHLFARTH

538.114

4200. On the mechanism of magnetic after-effect of a ferromagnetic substance. S. MAEDA. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **2**, 878–89 (*Dec.*, 1950).

A theory for the magnetic after-effect is proposed taking into account the irreversible displacement of the domain boundaries in a ferromagnetic substance. According to the theory, the characteristic nature of the after-effect does not change within wide ranges of magnetic field, applied tension and temperature. A simple formula for the approach to the equilibrium in magnetization is given on the basis of the theory. These theoretical results coincide well with experimental ones obtained in Cr permalloy. A.

538.114

4201. Spin waves in ferromagnetic and antiferromagnetic materials. F. KEFFER, H. KAPLAN AND Y. YAFET. *Amer. J. Phys.*, **21**, 250–7 (*April*, 1953).

A brief outline is given of the spin-wave approximation to the near ground states of ferromagnetism and antiferromagnetism. Simple pictorial models of spin waves are introduced. These models clarify the striking difference between ferromagnetic spin waves, which obey the dispersion law $\omega \propto k^2$, and antiferromagnetic spin waves, which obey the law $\omega \propto k$. The proper normal modes for antiferromagnetic spin waves are presented. The nature of ferromagnetic and antiferromagnetic resonance is illuminated from a spin-wave point of view. A.

538.114

4202. Magnetic structure transitions. J. S. SMART. *Phys. Rev.*, **90**, 55–8 (*April* 1, 1953).

The problem of magnetic phase transitions between ferromagnetism and antiferromagnetism, or between two different kinds of antiferromagnetic arrangement, is treated by a molecular field approach. It is shown that such transitions may occur if the molecular field coefficients vary with temperature; if they do occur, they will be of first order. The theoretical results agree qualitatively with the experimental results of Guillaud and Serres on MnAs. A.

538.114

4203. Overlapping energy bands and the theory of collective electron ferromagnetism. A. B. LIDIARD. *Proc. Cambridge Phil. Soc.*, **49**, *Pt I*, 115–29 (1953).

The theory of collective electron ferromagnetism given by Stoner applies to a system of electrons in a single energy band: for Fe, Co and Ni this is identified with the band of states derived from atomic 3*d* functions. To bring in the generally assumed overlapping of the 3*d* band by the wide 4*s* band in these metals, the theory has been extended to take account of the transfer of electrons from 3*d* to 4*s* states with change of temperature. A previous calculation of this transfer effect must be regarded as inadequate, for the part played by the exchange energy in determining the distribution of electrons between the two sets of states was omitted. The general equations are derived and used as a basis for discussion of the properties of Ni–Cu alloys at absolute zero. Numerical results are presented which show the effect of the overlapping 4*s* band on the magnetic properties of a system such as Ni both above and below its Curie point. Comparison with the measured paramagnetic susceptibility of pure Ni above the Curie point strongly suggests that for this metal the overlapping 4*s* band has only a minor influence, although in principle the effect could be very large. This result is not unambiguous, however, because values thus inferred for the two unknown parameters lead to inaccurate predictions below the Curie point. First, the predicted values for the spontaneous magnetization are too small. Secondly, the theory demands that the Ni–Cu alloys should only be ferromagnetic below a Cu content of about 20%, whereas experimentally the limit is known to be about 60%. In conclusion, it is suggested that the implicit assumption of Stoner's theory that the exchange integrals between all pairs of 3*d* states are equal to one another is a more serious restriction on the theory than the consideration of only a single energy band. A

538.2

4204. Behavior of magnetic materials. R. M. BOZORTH. *Amer. J. Phys.*, **21**, 260–6 (*April*, 1953).

A review of recent work in which the atomic theory of ferromagnetism and the domain theory of magnetization are applied to new materials.

538.22 : 548.7

4205. Mixing of states and antiferromagnetism. H. P. HANSON. Letter in *Phys. Rev.*, **89**, 115 (*March* 1, 1953).

Discusses the connection between the magnitude of superexchange forces in antiferromagnetic oxide

of transition metals and the amount of admixture of states in the wave functions as revealed by the magnitude of $3d$–$4s$ absorption in soft X-ray absorption curves of the pure transition metals, ionic compounds and oxides. E. P. WOHLFARTH

538.221

4206. Magnetization and microwave resonance absorption of the solid solutions of magnetic ferrites and cadmium ferrite. H. WATANABE, N. TSUYA AND T. TAKAHASHI. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **3**, 62–5 (*Feb.*, 1951).

The saturation magnetization of the solid solutions of magnetic ferrites and Cd ferrite was studied, and it was found that the saturation magnetization would become maximum at certain compositions of Cd ferrite, as in the case of solid solutions of magnetic ferrites and Zn ferrite. Microwave resonance absorption measurements were made on Ni–Cd ferrites, and the results were in unexpected disagreement with the theory, which might be interpreted by the idea of the "size effect" discussed by Yager and others. A.

538.221

4207. Magnetic resonance absorption in antiferromagnetic materials. T. OKAMURA, Y. TORIZUKA AND Y. KOJIMA. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **3**, 209–13 (*April*, 1951).

The microwave resonance absorptions in antiferromagnetic materials, MnS, MnO and MnSe, at 3·2 cm wavelength were studied by using a specially designed rectangular cavity at low temperature. The curves of resonance absorption versus d.c. magnetic field for these materials were obtained at various temperatures ranging from −195°C to 78°C. The height of the resonance absorption decreased and absorption line became broad with decreasing temperature, especially below the Curie temperature. The position of the maximum was found to be a constant magnetic field at 3510 Oe over these temperature ranges. The results have been discussed in comparison with the theoretical studies of magnetic resonance in antiferromagnetic materials. A.

538.221

4208. Microwave resonance absorption in magnetite at low temperature. T. OKAMURA AND Y. TORIZUKA *Sci. Rep. Res. Insts Tôhoku Univ. A*, **3**, 214–18 (*April*, 1951).

Microwave resonance absorption in magnetite single crystal was studied at the wavelength of 3·22 cm in the temperature range from room temperature to −185°C, and many interesting discrepancies were found between the results and those obtained by Bickford (1950). Double peaks were observed, from −166°C to −140°C, for [110] direction, and further, from −121°C to room temperature, for [100] direction; the double peaks always appeared in the temperature range at which the direction of the static field would correspond to the direction of difficult magnetization. The mechanism for the appearance of the double resonance peaks of high and low field strength is proposed. Moreover, it was noticeable that the absorptions were clearly observed for each crystal direction, [110] and [100], even below the transition temperature, and that the resonance fields and the line shape for the two directions coincided with each other below −172° down to −185°C. A.

538.221

4209. On the magnetic transition of nickel-ferrite at low temperature. T. OKAMURA AND J. SIMOIZAKA. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **3**, 223–8 (*April*, 1951).

The magnetic transition of nickel ferrite was investigated by measuring the magnetic property and electrical conductivity at low temperature. From the results of these measurements, existence of the transition of nickel ferrite in the range of *c.* −100° to −200° was confirmed. It was noticed that the present transition had two remarkable characteristics different from those of magnetite; one was large temperature range of the transition, and the other was the disappearance of the magnetic anomaly at comparatively low magnetic field. The problem of applying the Verwey model to the present transition was discussed. A.

538.221

4210. Ferromagnetic resonance absorption in $NiOFe_2O_3$ and a new magnetic transition at low temperature. T. OKAMURA AND Y. TORIZUKA. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **3**, 219–22 (*April*, 1951).

Microwave absorption phenomena, similar to those reported by Bickford (1950) for magnetite, were observed for nickel ferrite. The measurements at a wavelength of 3·2 cm were made from room temperature down to −195°C. At the lowest temperature, two absorption peaks were obtained at 1490 Oe and 200 Oe, the latter gradually decreasing with rising temperature and finally disappearing at about −120°C. The value of the *g*-factor, the maximum absorption and the half line width increased with decreasing temperature. An anomaly of the intensity magnetization against temperature was also observed in the range −120° to −195°C. Thus a new magnetic transition of $NiOFe_2O_3$ at low temperature was found. A.

538.221

4211. Anomalous resonance absorption in cobalt ferrite and Co–Zn binary ferrites. Y. TORIZUKA. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **3**, 383–92 (*June*, 1951).

Microwave resonance absorption in Co-ferrite and Co–Zn binary ferrites at 3·22 cm wavelength were observed at high temperature and from room temperature to −195°C, respectively. Resonance absorption in Co ferrite could not be detected at the temperature below 40°C, because of a large anisotropic energy. Such phenomena had not been found in other ferrites, so the resonance experiment was undertaken at high temperatures ranging from 40° to Curie point. In Co–Zn binary ferrites, the absorption disappeared below the temperature of −90°C and −140°C in $4CoO.ZnO.5Fe_2O_3$ and $3CoO.2ZnO.5Fe_2O_3$, respectively, but the absorption in $CoO.4ZnO.5Fe_2O_3$ could be observed down to −186°C. The resonance fields corresponding to the maximum absorption were observed as a function of

the temperature. In the case of Co ferrite, the resonance field corresponding to the maximum absorption gradually decreased with increasing temperature up to *c.* 250°C and then rapidly increased to the Curie point. On the other hand, the absorption amount at first increased linearly with increasing temperature, afterwards passed through a maximum and then decreased rapidly up to the Curie point. The half line widths and *g*-factor were also obtained as functions of temperature up to the Curie point; the half line width steadily decreased with increase of temperature up to the Curie temperature, at which the absorption disappeared. The *g*-factor increased with the rise of temperature, afterwards passed through a broad maximum and then decreased rapidly to the Curie point; the value of the resonance field at about the Curie point was found to be within 3300 ± 100 Oe, for which *g*-factor was determined to be 2·02 ± 0·06, using the paramagnetic resonance condition. A.

538.221

4212. Ferromagnetic resonance in various ferrites at low and high temperatures. T. Okamura, Y. Kojima and Y. Torizuka. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **3**, 725–39 (*Dec.*, 1951).

Ferromagnetic resonances in Mn, Cu and Mg ferrites and Ni–Zn binary ferrites were tried at low and high temperatures at the frequency of 9310 Mc/s; in the temperature range of magnetic transition for Mn ferrite, double peaks were observed; with lowering of the temperature, a small peak at low field overlapped the ordinary large peak showing an asymmetrical resonance curve which tended to be symmetrical at the lowest temperature. *g*-Factors and half line widths were determined up to the Curie temperatures. In general, the line width of simple ferrites decreases steadily to the Curie temperature, but those of binary ferrites containing Zn ferrite first decreases rapidly with rising temperature from the liquid Ni temperature and then increases near the Curie temperature; especially, it is most interesting to notice that the curve of line width *v.* temperature for high Zn ferrite in Zn–Ni ferrites shows minimum and maximum, the behaviour seems to correspond to a type predicted by Néel, which appears in the diagram for saturation magnetization *v.* temperature. The *g*-factor of various Ni–Zn binary ferrites at the Curie point was determined, using the paramagnetic resonance condition; the value of the *g*-factor steadily decreases with increasing content of Zn ferrite. This fact is in contradistinction to the change of *g*-value with varying Zn content in Zn–Ni ferrites at room and low temperatures. The size effect reported by Beljers and Polder could not be observed for Ni ferrite and Ni–Zn binary ferrite at the frequency of 9310 Mc/s, but recently it was observed at 23 500 Mc/s, at room and low temperature, on several ferrites. A.

538.221

4213. Ferromagnetic behavior of nickel-cobalt alloys. M. Yamamoto. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **4**, 14–27 (*Feb.*, 1952).

With about 60 annealed Ni–Co alloys covering the whole composition range, the magnetization curves for magnetic fields up to about 900 Oe were measured ballistically at room temperature and the magnetization for various constant fields, saturation magnetization and field, magnetocrystalline anisotropy constant, and initial and maximum susceptibilities as functions of composition were determined. The data indicate that the two-phase range in the Ni–Co system extends approximately from 68 to 78% Co at ordinary temperatures, contrary to the prevailing opinion. A.

538.221

4214. Ferromagnetic resonance in the single crystals of some ferrites. I. T. Okamura, Y. Kojima and Y. Torizuka. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **4**, 72–84 (*Feb.*, 1952).

Single crystals of Mn–Zn ferrite were studied at 3·22 cm wavelength, and Co–Zn ferrite at 3·22 and 1·27 cm at temperatures from −195°C to the Curie point. Resonance phenomena in the polycrystalline specimens having the same composition were also studied. The magnetic transition through which the first-order magnetocrystalline anisotropy constant K_1 changes its sign were found respectively, at *c.* −100°C and +70°C for both ferrites and near these temperatures two resonance peaks appeared on the resonance curves of polycrystalline specimens. The half line widths were found to depend on the crystallographic directions; their temperature dependence was also observed. *g*-Factors and K_1 of Co–Zn ferrite were observed as functions of temperature. For Co–Zn ferrite, the temperature dependence of the line width showed a complicated behaviour at first by a rough measurement, but it was found to be regular by a further precise investigation. *g*-Value and the order of K_1 of Mn–Zn single crystal at room temperature agreed with the results of Galt and co-workers (1950–51), but large discrepancies between the present results and those of Galt's are found in the sign of K_1 and the value of the half line width at room temperature; the latter seems to be attributable to the "size effect." A.

538.221 : 538.24

4215. The approach to saturation in dilute ferromagnetics. A. D. Franklin and A. E. Berkowitz. *Phys. Rev.*, **89**, 1171 (*March* 15, 1953).

The law of approach to magnetic saturation in finely divided and diluted iron powders has been studied. For samples containing volume fractions of Fe greater than about 0·6, Néel's theory of fluctuation-controlled approach is valid. As the concentration of Fe decreases, the deviation from the theory increases in the direction of steeper approach. A.

538.221 : 539.4.016

4216. Effects of cold working and heat treatment on the magnetic properties of nickel sheets. T. Fukuroi and K. Yasuhara. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **3**, 687–97 (*Dec.*, 1951).

Pure Ni sheets of about 50 microns in thickness were cold rolled to varied degrees of reduction up to 77% and the magnetic properties measured by means of a torsion magnetometer in the directions parallel and perpendicular to the roll direction before and after the heat treatments at temperatures below

and above the recrystallization temperature. Anisotropies were found for all magnetic properties, the magnetic properties and their anisotropies varying somewhat regularly with the reduction in thickness by cold rolling. The annealing at a temperature below the recrystallization temperature increases the value of the initial susceptibility and its anisotropy of the cold rolled specimen. The variations in the initial susceptibility and coercive force are discussed in terms of fibre structure and internal stress. A.

538.222

4217. Dipolar broadening of magnetic resonance lines in magnetically diluted crystals. C. KITTEL AND E. ABRAHAMS. *Phys. Rev.*, **90**, 238–9 (*April* 15, 1953).

Calculations are given for the frequency moments associated with the dipolar broadening of magnetic resonance lines in crystals having lattice points populated at random by identical paramagnetic ions or nuclei. It is found that for fractional magnetic population $f > 0{\cdot}1$ the line shape is approximately Gaussian with a width proportional to $f^{\frac{1}{2}}$; for $f < 0{\cdot}01$ the line shape is approximately Lorentzian with a width proportional to f. A.

538.222 : 536.63

The thermal and magnetic properties of palladium-silver alloys. *See Abstr.* 4064

538.231 : 621.3.013 : 621.318.1

4218. Theory of the coercive field of magnetic materials. S. VELAYOS HERMIDA. *Rev. Cienc. apl.*, **6**, 385–408 (*Sept.–Oct.*, 1952) *In Spanish.*

Soft and hard materials are discussed, magnetization and demagnetization, magnetic energy, transition between two regions magnetized in different directions, and the various theories of the coercive field, are considered, more especially the theory of non-uniform distribution of strain, and the theory of inclusions. The coercive field of small particles and the effect of crystalline anisotropy are discussed.

J. A. WILCKEN (R)

538.245

4219. The preferred direction in a magnetically hardened permanent magnet alloy. M. MCCAIG. Letter in *J. appl. Phys.*, **24**, 366 (*March*, 1953).

Describes experiments on columnar disks of Alcomax III, the columnar axis being along a diameter. The preferred direction was determined after cooling in a magnetic field parallel to a diameter and at different angles with the columnar axis. The effect of different cooling rates was also investigated.

E. P. WOHLFARTH

ELECTROMAGNETISM . ELECTRODYNAMICS 538.3/.5

538.3 : 532.5

4220. Steady motion of conducting fluids in pipes under transverse magnetic fields. J. A. SHERCLIFF. *Proc. Cambridge Phil. Soc.*, **49**, *Pt I*, 136–44 (1953).

Studies the steady motion of an electrically conducting, viscous fluid along channels in the presence of an imposed transverse magnetic field when the walls do not conduct currents. The equations which determine the velocity profile, induced currents and field are derived and solved exactly in the case of a rectangular channel. When the imposed field is sufficiently strong the velocity profile is found to degenerate into a core of uniform flow surrounded by boundary layers on each wall. The layers on the walls parallel to the imposed field are of a novel character. An analogous degenerate solution for channels of any symmetrical shape is developed. The predicted pressure gradients for given volumes of flow at various field strengths are finally compared with experimental results for square and circular pipes. A.

538.52

4221. The induction of electric currents in a uniformly conducting circular disk by the sudden creation of magnetic poles. A. A. ASHOUR. *Quart. J. Mech. appl. Math.*, **5**, 379–84 (*Sept.*, 1952).

Using toroidal co-ordinates, a double space of two regions is constructed as in Sommerfeld's theory. The Riemann potential for a single pole is obtained and Jeans's treatment of uniform finite plane current sheets is applied to the case of the circular disk. A.

ELECTROMAGNETIC WAVES AND OSCILLATORS 538.56

538.56 : 523.11

4222. Equations of motion for an ideal plasma. I. SPITZER, JR. *Astrophys. J.*, **116**, 299–316 (*Sept.*, 1952).

Equations are presented for the motion of a completely ionized gas, or plasma, in a magnetic field sufficiently strong so that during a single gyration around a Larmor circle the relative changes in all macroscopic quantities, such as the electrical and magnetic fields, $\boldsymbol{E}$ and $\boldsymbol{B}$, the particle density, n, and the kinetic temperature, T, are very small. The ratio of the radius of curvature, a, of a Larmor circle to the mean free path, λ, is also assumed small. Successive approximations are developed in increasing powers of these small quantities. Since, in the plane perpendicular to $\boldsymbol{B}$, an electrical current arises primarily from a pressure gradient, while an electrical field produces a uniform velocity of the plasma, the current density and the electrical field have no direct relationship. Hence the electrical resistivity is most conveniently defined in terms of the energy dissipated into heat by an electrical current. So defined, the transverse resistivity is $1{\cdot}96$ times the normal resistivity for currents parallel to the magnetic field. While no steady current parallel to $\boldsymbol{E}$ is directly produced by a transverse electrical field, a change in $\boldsymbol{E}$ produces a polarization of the plasma; in interstellar space the transverse dielectric constant is about 10^8. The Hall current, perpendicular to both $\boldsymbol{E}$ and $\boldsymbol{B}$, appears only in the third approximation and is generally negligible. Approximate equations for the transverse viscosity and heat conductivity are given. Both of these effects are very small. A.

538.56 : 523.75 : 523.152.2

Magneto-hydrodynamic shock waves. *See Abstr.* 3799

538.561 : 535.343.4–14

Molecular spectroscopy with a Hertzian oscillator source of millimeter waves. *See Abstr.* 4017

538.561 : 537.542

4223. Spontaneous oscillations in gas discharge tubes. L. E. BRENNAN. *Univ. Microfilms Publ. No.* 2712 (1951) 60 *pp.* (Photo-reproduction.)

Abstract in *Microfilm Abstracts*, **11**, *No.* 4, 973–4 (1951). See also Abstr. 2511 (1950).

538.561 : 537.542

4224. On the causes of "spontaneous" microwave oscillations in gaseous discharges. J. A. SALOOM, JR. *Univ. Microfilms Publ. No.* 2743 (1951) 74 *pp.* (Photo-reproduction.)

Abstract in *Microfilm Abstracts*, **11**, *No.* 4, 981–2 (1951).

538.566 : 621.3.013 : 621.396.671

4225. Electromagnetic radiation fields. H. ZUHRT. *Berlin: Springer-Verlag* (1953) xiv + 473 *pp.*, 170 *figs.*

Part A deals with the theory of radiation fields, in particular with the various methods of solution of Maxwell's equations. Part B describes the field around conducting wires and inside waveguides. Part C deals with radiation from the main types of aerials: in particular cylindrical linear aerials are treated in detail with original contributions. Part D treats problems of wave propagation especially in the atmosphere. The book appears up to date and contains various topics that cannot be found in other treatises. The bibliography is mainly confined to German and American contributions. L. PINCHERLE

538.566

4226. Diffraction by an edge and by a corner. D. S. JONES. *Quart. J. Mech. appl. Math.*, **5**, 363–78 (*Sept.*, 1952).

Sufficient conditions are given to ensure that the current density normal to an edge is zero at the edge and that there is no line distribution of charge on the edge. An extra condition makes the components of the field parallel to the edge finite. The solution is then shown to be unique. Simpler conditions are given for two-dimensional fields. The agreement with various known solutions is discussed. It is shown that certain simple current densities lead to a unique solution for the diffraction by corners of flat surfaces. A.

538.566 : 621.3.013.78

4227. Theory of electro-magnetic shielding by a shielding room of wire-netting. T. MATSUMOTO. *Monogr. Res. Inst. Appl. Elect. Hokkaido Univ., No.* 3, 18–29 (1952).

The theory developed in a previous paper [Abstr. 4548 (1951)] for the shielding of an infinitesimally small source in a spherical wire mesh room is extended to large sources by consideration of the associated higher modes. A theory of double screening is developed. A cylindrical room having one end of netting and the next of perfectly conducting walls is considered. Such a system provides a means of assessing the screening of netting. The resonant wavelengths of spherical and hemispherical rooms containing large metallic structures are considered. W. T. BLACKBAND (R)

538.566 : 621.3.011.23 : 621.392.26

4228. The susceptance of a circular obstacle to an incident dominant circular-electric wave. L. S. SHEINGOLD. *J. appl. Phys.*, **24**, 414–22 (*April*, 1953).

The problem of the susceptance of a circular obstacle in a circular waveguide with an incident TE_{01} mode is solved by a variational method. Theoretical expressions are obtained which are in good agreement with experimental results. Curves of normalized susceptance as a function of relative aperture, guide wavelength, and free-space wavelength are included. A.

538.566 : 621.392.26

4229. The Faraday rotation of waves in a circular waveguide. H. GAMO. *J. Phys. Soc. Japan*, **8**, 176–82 (*March–April*, 1953).

Exact solutions of the magnetic rotation of the guided waves in a circular waveguide of infinite length are described, whereby the rotational terms in both magnetization and electric polarization are considered. The normally degenerate modes of the circular guide are separated by the external magnetic field into two partial waves—i.e. the right-handed and left-handed circularly polarized waves, which are neither transverse-electric nor transverse-magnetic but are reduced to the TE- or TM-mode in the limit of vanishing magnetic field. The propagation constant of each partial wave is determined by a transcendental equation derived from the boundary conditions. Curves giving the frequency dependency of the propagation constants for both partial waves are shown for the quasi-TE_{11}-modes, and quasi-TM_{11}-modes for a special value of the coefficients of rotational terms. The dependence of the cut-off frequencies on these coefficients is also obtained. For TM-modes, the cut-off frequencies of both partial waves are found to coincide. A.

538.566.2 : 621.396.11

4230. Some notes on theory of radio scattering in a randomly inhomogeneous atmosphere. H. FINE. Letter in *Proc. Inst. Radio Engrs.*, **41**, 294 (*Feb.*, 1953).

Considerations of suitable definitions of correlation functions for use in radio scattering. Booker and Gordon [Abstr. 1547 (1951)] have proposed a space correlation which leads to values of the instantaneous scattered power, while Staras (*Nat. Bur. Stand. Rep.* 1662, Washington) used a time correlation which gives the received average scattering power. The author develops a time-space correlation function which embraces both these. G. M. BROWN

538.566.2 : 621.396.11

4231. Scattering of 56 Mc/s radio waves from the lower ionosphere. P. A. FORSYTH, B. W. CURRIE AND F. E. VAWTER. Letter in *Nature* [*London*] **171**, 352–3 (*Feb.* 21, 1953).

Diffuse signals observed on 56 Mc/s at Saskatoon (52.1°N) between February and June, 1952, appeared to arise at a height of about 85 km. The echo was strongest in March, and showed a minimum amplitude in the late afternoon. It seems likely that the signals

are produced by back-scatter from horizontal stratifications of ionization in the lower ionosphere.

G. M. BROWN

538.566.2 : 621.396.11

4232. Effect of a large dielectric constant on ground-wave propagation. J. R. WAIT AND L. L. CAMPBELL. Note in *Canad. J. Phys.*, **31**, 456–7 (*March*, 1953).

Curves relating field strength and distance from transmitter at 200 kc/s are given for values of permittivity between 2 and 200. For ground conductivities of $< 1{\cdot}0\times10^{-14}$ e.m.u. the field strength can vary by a factor of as much as 100 according to the value of permittivity taken. G. D. SIMS

538.566.3

4233. Effect of magnetic field in oblique propagation over equatorial region. B. CHATTERJEE. *Indian J. Phys.*, **26**, 397–412 (*June*, 1952).

Discusses in a simplified manner the effect of magnetic field in oblique propagation of radio waves, with special reference to propagation across the equatorial region. A few sets of propagation curves have been drawn for transmission across the equatorial region, after Booker. The phenomenon of lateral deviation has been discussed in a simple manner. Propagation curves for two special cases of transmission, Calcutta–Bandoeng and Calcutta–Bombay, are also given. A.

538.566.3 : 621.396.11

4234. Long-delay ionospheric echoes at 150 kc/s. J. J. GIBBONS, R. L. SCHRAG AND A. H. WAYNICK. Letter in *Nature* [*London*] **171**, 444–5 (*March* 7, 1953).

Simultaneous recordings of the unsplit ordinary and extraordinary components far from the critical frequency have been made using a circularly polarized receiving aerial system at Pennsylvania. Extraordinary mode echoes have been received at night in November 1952 from a height of 900–950 km. Of the possible interpretations it is considered very likely that these echoes correspond to the "fourth reflection condition" indicated theoretically for the extraordinary component at a height of 940 km for this frequency in an assumed model. G. M. BROWN

MAGNETIC EFFECTS 538.6

538.632

4235. The Hall coefficient of calcium. V. FRANK AND O. G. JEPPESEN. Letter in *Phys. Rev.*, **89**, 1153–4 (*March* 1, 1953).

Measurements yield a value for R_H of $-(17{\cdot}8 \pm 0{\cdot}5)\times10^{-5}$ cm^3 coulomb^{-1}. C. A. HOGARTH

538.65 : 532.51

The stability of viscous flow between rotating cylinders in the presence of a magnetic field. *See Abstr.* 3905

538.652

4236. On the temperature dependence of the magnetostriction constants in iron. T. KATAYAMA. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **3**, 341–55 (*June*, 1951).

A formula for magnetostriction of iron single crystal was deduced by taking spin × orbit interaction among electrons belonging to the said ferromagnetic crystal. In this case the eigenfunction of the 3*d* electronic energy zone was constructed by the lattice function method for the tightly bound type. The energy of the spontaneously strained crystal was evaluated on the basis of a proper function belonging to an irreducible group of cubic symmetry. The numerical result was evaluated approximately, roughly reproducing the order of magnitude of the magnetostriction together with its temperature dependence. A.

538.653.11

4237. The saturation magnetization of nickel at high pressure. G. O. JONES AND F. D. STACEY. Letter in *Proc. Phys. Soc.* [*London*] *B*, **66**, 255–6 (*March*, 1953).

Describes measurements by a method due to Bridgman. The saturation magnetization was found to increase by about 11% as the pressure increased to 10^4 atmospheres. E. P. WOHLFARTH

MOLECULAR AND ATOMIC STRUCTURE 539.1

THEORY OF SOLID STATE 539.11

539.11

4238. Second neighbour interaction in regular binary assemblies. G. M. BELL. *Phil. Mag.*, **44**, 65–76 (*Jan.*, 1953).

A study is made of regular assemblies of species A and B, whose configurational energy is given by the expression $w_1N_{AB}(1) + w_2N_{AB}(2)$, $N_{AB}(1)$ and $N_{AB}(2)$ being the numbers of first and second neighbour A–B pairs respectively. Positive and negative values of w_1 and w_2 are treated and results apply to phase-separation, order-disorder and Ising ferromagnets and antiferromagnets at zero field. Generalized quasichemical approximations giving the correct ratio of total first and second neighbour pair numbers are used and the consistency is checked by the critical points in the limiting cases $w_1 = 0$ and $w_2 = 0$ and by the value of w_2/w_1 at which the critical temperature becomes zero. The simple cubic lattice is treated in detail and a critical temperature curve derived for the plane square lattice. Fluctuation effects are diminished for reinforcing first and second interactions and increased for opposing ones. The quadruplet approximation which has been used by certain authors is critically examined and it is pointed out that it would be consistent for the disordered state on the face-centred cubic lattice. A.

539.11

4239. The state of solid methane as inferred from nuclear magnetic resonance. K. TOMITA. Letter in *Progr. theor. Phys.*, **8**, 138–40 (*July*, 1952).

The data of Thomas, Alpert and Torrey (1950) are analysed by perturbation methods (one-parameter theory). Changes in the mechanism for spin-lattice relaxation occur at 20°K (λ point), 65°K (anomaly yet undetected) and 90°K (melting point), A mechanism for the 65°K change is discussed. L. PINCHERLE

539.11

4240. Note on the electronic structure of the transition metals. N. F. Mott. *Phil. Mag.*, **44**, 187–90 (*Feb.*, 1953).

A discussion is given of the Van der Waals forces between the 3*d* and 4*d* shells of transition metals, and it is shown that a consideration of their nature may account for the low number of conduction electrons (0·6) in these metals and their alloys. A.

539.11

4241. The electronic band structure of PbS. D. G. Bell, D. M. Hum, L. Pincherle, D. W. Sciama and P. M. Woodward. *Proc. Roy. Soc. A*, **217**, 71–91 (*March* 24, 1953).

The cellular method has been applied to the determination of electronic wave functions of the Bloch type in PbS. In each cell ψ is expanded in terms of "Kubic harmonics," and a table of these functions (for a NaCl type of lattice) for prominent points in momentum space is included. An attempt has been made to establish a self-consistent field, by treating only the electrons with $k = 0$, but results have shown that this approximation is not very good. Methods of matching the wave functions at the boundaries between the cells are described, based either on least square fitting or on expansion of ψ in terms of functions which are orthogonal over the boundaries. These methods have been tested with the empty lattice test. Curves are given showing the approximate band structure in two prominent crystallographic directions. The resulting width of the full band is about 6 eV, that of the conduction band about 7 eV. The forbidden energy gap is very small ($< 0{\cdot}3$ eV). The lowest allowed optical transition has a wavelength of $0{\cdot}9\,\mu$. These results are in agreement with the observed absorption spectrum and suggest that its tail is due to forbidden transitions. The calculated rate of change with temperature of the energy gap is 2×10^{-4} eV/degree, about half the experimental value. A.

539.11

4242. The exchange energy of nearly free electrons in metals. E. P. Wohlfarth. *Phil. Mag.*, **44**, 281–8 (*March*, 1953).

Describes calculations of the exchange energy of an assembly of nearly free electrons of low density. Two differing one-electron wave functions are used, both concerning a nearly empty Brillouin zone. It is found in both cases that the total exchange energy is much less sensitive to changes of the effective mass of the electrons than is the Fermi energy. Previous related work is referred to and the bearing of the results on some physical properties of metals is indicated. A.

539.11 : 539.32

Theoretical study of Young's moduli of binary solid solutions. *See Abstr.* 4418

539.11 : 548.7

4243. A note on the interaction between electrons and lattice vibrations in metals. H. Kanazawa. *Sci. Pap. Coll. Gen. Educ. Univ. Tokyo*, **1**, 41–4 (*Oct.*, 1951).

It is pointed out that there are static interactions between pairs of electrons, in addition to the self energies vital in Fröhlich's theory of superconductivity [Abstr. 325 (1951)]. The Hamiltonian is transformed into diagonal form, and an expression is derived for the static potential and also for its expectation value. E. H. Sondheimer

539.11 : 548.7

4244. On the lattice vibrations of a binary superlattice alloy. Y. Shibuya, Y. Fukuda and T. Fukuroi. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **3**, 1–12 (*Feb.*, 1951).

The result is given of a theoretical calculation on the vibrational modes of a β-brass alloy (CuZn) for the state of any degree of order which was carried out in accordance with the method of Born and von Kármán (1912). The 6th order secular equation finally obtained was solved with respect to the 3 principal directions [100], [110] and [111]. The ν–σ curves for the state of several specified values of the degree of order in the 3 principal directions were plotted. Owing to the fact that the ratio of masses of two kinds of atoms in β-brass is nearly unity, a significant change in the ν–σ curves in response to the change in the degree of order cannot be observed. However, a similar calculation in regard to Cu_3Au would reveal a more remarkable change in the ν–σ curves accompanying the change in the degree of order than that which appears in the present paper. A.

539.11 : 548.7

4245. On the vibrational spectrum and the vibrational specific heat of a binary superlattice alloy. Y. Shibuya, Y. Fukuda and T. Fukuroi. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **3**, 182–6 (*April*, 1951).

The change in the vibrational modes of a binary superlattice alloy due to the change in its own degree of order has been discussed previously (preceding abstract). It was then expected that the vibrational specific heat of the superlattice alloy would change in response to the change in its own degree of order. Using the result obtained formerly, the authors have now applied Houston's approximate method of finding the frequency distribution function $N(\nu)$ to the calculation of the vibrational specific heat of β-brass in the state of any specified degree of order. It is shown that the vibrational specific heat of the disordered alloy is generally larger than that of the ordered one at ordinary temperatures. If two kinds of atoms which are the components of the alloy are nearly equal in mass, the vibrational specific heat of the ordered alloy becomes larger than that of the disordered one at low temperatures. A.

539.11 : 548.736.4

Study on the superlattices of ternary alloys by X-ray. *See Abstr.* 4485

MOLECULAR STRUCTURE 539.13

539.132

4246. Some properties of the Racah and associated coefficients. L. C. Biedenharn, J. M. Blatt and M. E. Rose. *Rev. mod. Phys.*, **24**, 249–57 (*Oct.*, 1952).

Review of algebraic properties (definition, symmetry, selection rules, sum rules, recurrence formulae

and explicit expressions) and tables of the transformation coefficients between different coupling schemes arising in problems on composite wave functions with coupled angular momenta. In the problem of the angular distribution of scattering and reaction cross-sections [Abstr. 1100 (1953)] the results are useful in effecting the summations over the magnetic quantum numbers of a product of several vector addition (Clebsch–Gordan, Wigner) coefficients. Another important application, apart from Racah's work on complex atomic spectra, is to the angular correlation of successive radiations. Four tables for the Racah coefficients $W(l_1J_1l_2J_2; e, L)$ corresponding to the four values $e = \frac{1}{2}, 1, \frac{3}{2}, 2$, and for possible values of l_1 and l_2 in terms of J_1 and J_2, are included, while 54 available numerical tables are mentioned. Classified bibliography (19 references).

W. A. HEPNER

539.132 : 548.7

4247. Approximate formulas for many-center integrals in the theory of molecules and crystals. P.-O. LÖWDIN. Letter in *J. chem. Phys.*, **21**, 374–5 (*Feb.*, 1953).

A method is suggested for the evaluation of four-centre integrals as functions of the overlap integrals and the co-ordinates of the centres of gravity of the charge distributions $\psi_a\psi_b$ and $\psi_c\psi_d$. This relation is a generalization of formulae derived by Mulliken and Sklar: in the case of symmetrical charge distribution it is equivalent to Mulliken's formula and Sklar's relation can be derived from it if first moments only are taken into account. In general there is good agreement with results of accurate methods, except in certain degenerate cases. Expressions for total and cohesive energies of the ground state of a molecule or crystal, as derived previously can be simplified by the use of this relation. A. J. TAYLOR

539.132

4248. The potential function of ethylene. J. CHARETTE AND C. MANNEBACK. *Ann. Soc. Sci. Bruxelles*, **66**, 178–93 (*Dec.*, 1952) *In French.*

The potential coefficients have been calculated using experimental frequencies of C_2H_4 and C_2D_4. Planar vibration frequencies of deuterated ethylenes, redetermined on the basis of this potential function, fall within a few per cent of experimental values. The influence of anharmonicity on certain parameters is demonstrated. J. JACOBS

539.132

4249. The potential function of ethylene. B. L. CRAWFORD, JR, J. E. LANCASTER AND R. G. INSKEEP. *J. chem. Phys.*, **21**, 678–86 (*April*, 1953).

The infrared spectrum of *a*–$C_2H_2D_2$ has been obtained, and the vibrational frequencies used to complete the calculation of the force constants of C_2H_4. The spectra of C_2H_3D, *trans*-$C_2H_2D_2$, and a mixture of *cis*- and *trans*-$C_2H_2D_2$ were also observed and used to check the force-constant calculations. A.

539.132

4250. Normal coordinate treatment of diacetylene. S. M. FERIGLE AND A. WEBER. *J. chem. Phys.*, **21**, 722–5 (*April*, 1953).

A normal co-ordinate treatment for diacetylene is carried out, using Wilson's FG matrix method. Different sets of potential constants are obtained from the observed frequencies, and limits for these constants are set. The values of the potential constants are discussed in connection with the molecular structure. A.

539.132

4251. A formula for the oscillation frequencies of diatomic molecules of alkali metals. G. LOVERA. Letter in *Nuovo Cimento*, **9**, 442–4 (*May*, 1952) *In Italian.*

The formula is based on a theoretical model in which a pair of positive point charges (charge *ve*) is embedded in a rigid space distribution of negative electricity with spherical symmetry. The frequencies are then given by $\nu = 1979{\cdot}7\, v\, (K'/r_e^3\mu)^{1/2}\ \mathrm{cm}^{-1}$, where r_e is the equilibrium distance of the positive ions, μ their reduced mass, and K' a number depending on the oscillation quantum number. L. PINCHERLE

539.132

4252. On the oscillation frequencies of diatomic molecules containing atoms of the 4th, 5th, 6th and 7th groups. G. LOVERA. Letter in *Nuovo Cimento*, **9**, 541–3 (*June*, 1952). *In Italian.*

A comparison of experimental values with the formula suggested by the author (see preceding abstract). L. PINCHERLE

539.132

4253. Evidence for one-dimensional rotation in ammonium iodide. R. C. PLUMB AND D. F. HORNIG. Letter in *J. chem. Phys.*, **21**, 366–7 (*Feb.*, 1953).

In order to solve the problem, presented by the discrepancy in previous results, as to which is the correct structure of NH_4I, spectra were taken of the face-centred cubic modification. The observations were consistent neither with a statistically disordered model, nor with three-dimensional free rotation. The structure with one N–H bond directed at an iodine ion has minimum energy. This suggests a model with free rotation about the N–H–I axis. The height of the rotation barrier was calculated as well as the zero-point vibration energy and the perpendicular torsional oscillation. A. J. TAYLOR

539.132

4254. Intensities of vibration-rotation bands. R. C. HERMAN AND K. E. SHULER. Letter in *J. chem. Phys.*, **21**, 373–4 (*Feb.*, 1953).

With the use of Morse wave functions a formula was derived for the transition probability matrix elements. This formula is equivalent to that found by Heaps and Herzberg [Abstr. 738 (1953)], but more compact. A. J. TAYLOR

539.132 : 537.533.74

4255. Excitation of molecular rotation–vibration by electron impact. P. M. MORSE. *Phys. Rev.*, **90**, 51–5 (*April* 1, 1953).

The integral equation for the scattering of an electron from a symmetric diatomic molecule is solved approximately to obtain the effective interaction integral between the electron and the molecular vibration-rotation, neglecting polarization and exchange. This interaction depends on the difference of phase of the incident wave function between the two nuclear centres and thus on the momentary

direction and magnitude of the internuclear radius vector. From this interaction function the effective cross-sections for rotation-vibration excitation are computed and, by various sum rules, a closed formula for mean loss of energy of the electron to molecular rotation–vibration is obtained. This is compared with the corresponding loss of energy of the rebounding electron to the motion of the centre of gravity of the molecule. These two quantities are shown to be the same order of magnitude, their ratio changing from $\frac{1}{3}$, for very small equilibrium internuclear distance, to 1, for very large internuclear distance. A.

539.132

4256. Calculation of electronic energy levels of indene. G. VISWANATH. Letter in *Curr. Sci.*, **21**, 275–6 (*Oct.*, 1952).

Indene contains a six- and a five-ring. The energy levels were calculated with Sklar's valence bond method. Seven canonical structures were taken into account. Four energy levels were found, as complex roots of the secular equation had to be rejected. The wavelength of the transition between the ground state and the first excited state is found to be 3228 Å. The experimental value is 2952 Å. A. J. TAYLOR

539.132 : 537.312.5

Photoelectric emission and energy structure of Cs_3Sb. *See Abstr.* 4102

539.132

4257. Low frequency resonances in the spectra of diatomic molecules. R. E. COTÉ AND P. KUSCH. *Phys. Rev.*, **90**, 103–11 (*April* 1, 1953).

The molecular beam magnetic resonance method has been used in the study of some previously unobserved resonances in NaF, NaCl, NaBr, NaI and KBr. The frequency and intensity distribution within the resonance spectra have been studied at zero external field and the dependence of both the frequency and the shape of the resonance spectra on external magnetic field has been determined. At zero field these resonances fall in the frequency range from 0 to 157 kc/s and occur because of a quadrupole interaction and from a cosine interaction between I and J. At sufficiently high field, the frequency of the maxima of the resonances is $2g_I\mu_0 H/h$. The lines are ascribed to a transition between the levels $F = J + \frac{1}{2}$ and $F = J - \frac{1}{2}$. In most respects the lines fulfill theoretical predictions; the frequencies of the lines at zero magnetic field, however, deviate considerably from those predicted from other data. A.

539.132

4258. Spin interactions of accelerated nuclei in molecules. N. F. RAMSEY. *Phys. Rev.*, **90**, 232–3 (*April* 15, 1953).

The contributions to the spin-rotational magnetic interaction of a nucleus in a molecule of terms dependent on the acceleration of the nucleus are calculated. One of these arises from the fact that the acceleration in molecules is electrical and the moving nuclear magnetic moment interacts with the electric field. The other is the Thomas precession similar to that which occurs for electrons in atoms. The effects of both centripetal acceleration and zero point vibration acceleration are considered; the latter produces the largest effect. A general expression for the combined effect of these terms is given. When it is averaged over the zero point vibration of the H_2 and D_2 molecules, the contribution to the spin-rotational interaction constant c is 1050 c/s for H and 30·6 c/s for D. A.

539.132

4259. The molecular orbital theory of chemical valency. XIII. Orbital wave functions for excited states of a homonuclear diatomic molecule. A. C. HURLEY. *Proc. Roy. Soc. A*, **216**, 424–33 (*Feb.* 10, 1953).

The expansions for the exact wave functions for excited states of homonuclear diatomic molecules derived in Pt XII [Abstr. 3510 (1953)] are used as the basis for discussing various approximate wave functions of the orbital type. The states considered in detail are the lowest states of symmetries $^1\Sigma_u^+$, $^3\Sigma_u^+$. The calculus of variations is used to determine the optimum forms for the component orbital functions. A transformation to equivalent orbitals is used to bring out the physical significance of the various wave functions, and to relate the present theory to earlier theories, in particular the molecular orbital theory, the valence-bond theory and their generalizations. A.

539.132

4260. Electrical polarizability as a criterion for molecular wave functions. J. A. ABBOTT AND H. C. BOLTON. *Proc. Roy. Soc. A*, **216**, 477–92 (*Feb.* 24, 1953).

A method is developed for obtaining the wave functions of homonuclear diatomic molecules. The method is a "self-consistent" one, since successive adjustments are made to the parameters in the wave function, making the calculated values of the electrical polarizability converge to the experimental ones. A preliminary discussion analyses the influence of electron correlation and hybridization on polarizability, and the method is briefly applied to H_2^+ and H_2, during which rules are found for using the self-consistent method. The major part of the paper is devoted to the study of the N molecule. The filled orbitals are represented by an orthonormal set which is constructed using the Schmidt process. The latter process enables much reduction to be made in the numerical computation. A full discussion is given of the various wave functions, most attention being given to the completely antisymmetric one. The π bonds in N_2 are shown to have too great a longitudinal extension at large distances from the centre of the molecule, and this is empirically corrected by bringing closer together the atomic orbitals out of which the π bonds are made. Finally, the degrees of hybridization in the orbitals are given, and also the contributions which each orbital makes to the polarizability of the molecule. A.

539.132

4261. An improvement in the π-electron approximation in LCAO OM theory. R. PARISER. Letter in *J. chem. Phys.*, **21**, 568–9 (*March*, 1953).

The effect of the σ electrons in complex unsaturated molecules which is usually neglected in calculations of the energy levels of the π electrons, is sometimes

considerable. This can be taken into account by a change in the value of the Coulomb repulsion integrals. It is assumed that the energy of σ electrons is affected only in ionic resonance structures. The repulsion integral of such a structure is evaluated with the use of experimental values for ionization potential and electron affinity, and also with the use of Slater orbitals. There is a considerable discrepancy between the two results. It is suggested that changes in other repulsion integrals, apart from that between charged atoms, might improve the results.

A. J. TAYLOR

539.132

4262. A mnemonic device for molecular orbital energies. A. A. FROST AND B. MUSULIN. Letter in *J. chem. Phys.*, **21,** 572–3 (*March*, 1953).

A simple graphical method is suggested for the evaluation of M O energy levels in open chain and ring molecules. The levels found correspond to the values of Hückel's method in its simplest form.

A. J. TAYLOR

539.132

4263. The generalization of the WKB method to radial wave equations. R. H. GOOD, JR. *Phys. Rev.*, **90,** 131–8 (*April* 1, 1953).

There are two difficulties which arise in connection with the usual generalizations of the WKB method to the Schrödinger and Dirac radial wave equations. One difficulty is that, in deriving the approximations, the Dirac radial equation, the Schrödinger radial equation, and the one-dimensional Schrödinger equation are treated nonuniformly so that the approximate solutions are not simply related to each other in the same way that the original equations are. The other difficulty is that the Dirac radial WKB approximation cannot be applied to a certain type of bound state. In this paper it is shown that these difficulties can be avoided by using as the basis for the WKB method, instead of the customary exponential function, the functions which arise in solving the free-particle problem. In the radial problems these are Bessel functions of order integer-plus-one-half. As well as avoiding the difficulties mentioned above, this technique has the following additional advantages. In the radial problems connection formulae across the turning points are not required. The eigenvalue condition for the bound states arises from a comparison of asymptotic expressions in such a way that one would expect the approximate eigenvalues to be close to the exact ones. For a free particle the approximate wave functions become identical with the exact wave functions, so the accuracy of the approximation increases with increasing energy. On the other hand, the approximations based on Bessel functions have the disadvantages that they are clumsier to apply than the usual approximations and that they give especially poor results near the turning points. A.

539.133

4264. Addendum: Directed valence as a property of determinant wave functions. H. K. ZIMMERMAN, JR AND P. VAN RYSSELBERGHE. Letter in *J. chem. Phys.*, **21,** 381 (*Feb.*, 1953).

It is stated that the idea of deriving directed valence properties from atomic wave functions originated with one of the authors, but was not published at the time, and not with the author mentioned by Coulson [*Ann. Rev. Phys. Chem.*, **3,** 1 (1952)]. A. J. TAYLOR

539.133

4265. The structures of the interhalogen compounds. I. Chlorine trifluoride at −120°C. R. D. BURBANK AND F. N. BENSEY. *J. chem. Phys.*, **21,** 602–8 (*April*, 1953).

A technique has been developed for handling the extremely reactive interhalogen compounds which makes it possible to investigate their structures by X-ray diffraction at low temperatures. As the first step in a programme of study of the interhalogen group the crystal structure of chlorine trifluoride has been determined at −120°C. The chlorine trifluoride molecular is planar with the point group symmetry mm. The Cl atom is bonded to one F atom at 1·621 Å and to two F atoms at 1·716 Å. The F–Cl–F bond angle is 86° 59′. A parallel investigation of the vapour phase by microwave spectroscopy is reported in the abstract following. The molecular configuration is identical in the two cases. A.

539.133

4266. The microwave spectrum and structure of chlorine trifluoride. D. F. SMITH. *J. chem. Phys.*, **21,** 609–14 (*April*, 1953).

A microwave spectrometer designed for the study of microwave spectra of corrosive fluorine compounds has been used to observe and measure a portion of the microwave spectrum of chlorine trifluoride. A number of transitions have been identified, and from these the moments of inertia and quadrupole coupling coefficients of both $Cl^{35}F_3$ and $Cl^{37}F_3$ obtained. An intensity alternation was observed showing that the ClF_3 molecule has a C_{2v} axis and is planar. The moments of inertia confirm this and further show that ClF_3 has a distorted "T" structure with one short (1·598 Å) and two long (1·698 Å) ClF bonds. The angle between the two different kinds of ClF bonds is 87° 29′. The quadrupole coupling coefficients $\chi_{aa}(Cl^{35}F_3) = -81._2$ Mc/s, $\chi_{bb}(Cl^{35}F_3) = -64._7$ Mc/s, $\chi_{cc}(Cl^{35}F_3) = 146$ Mc/s agree with the observed frequency, $f(Cl^{35}F_3) = 75 \cdot 129_5$ Mc/s, of the pure quadrupole spectrum of ClF_3, which corresponds to an eqQ of 150 Mc/s. A.

539.133 : 548.7

4267. A nuclear magnetic resonance investigation of solid *cyclo*hexane. E. R. ANDREW AND R. G. EADES. *Proc. Roy. Soc. A*, **216,** 398–411 (*Feb.* 10, 1953).

The nuclear magnetic resonance absorption spectrum and the spin-lattice relaxation time have been measured for the protons in polycrystalline *cyclo*hexane between 100°K and its freezing-point (279·6°K). It has been found that the second moment (mean square width) of the measured spectrum for temperatures at which the lattice is effectively rigid, namely, below 150°K, is consistent with a molecular structure having D_{3d} symmetry, tetrahedral bond angles, C–C bond lengths of 1·54 Å and C–H bond lengths of 1·10 Å. If the HCH angle is treated as a parameter to be determined, it is found to be $107\frac{1}{2} \pm 3°$. On warming from 155 to 180°K the second moment decreases to a value which indicates the reorientation

of the molecules about their triad axes. Analysis of the spin-lattice relaxation time, which falls rapidly in this temperature range, shows that the height of the barrier hindering this reorientation is 11 ± 1 kcal/mole. Just below 186°K, the temperature at which there is a polymorphic change, the reorientation frequency is of the order 10^6 c/s. The polymorphic transformation is accompanied by discontinuous changes in the second moment and the relaxation time. It is concluded that in the higher temperature modification the molecules have a considerable freedom of reorientation, such that the intramolecular contribution to the second moment becomes negligibly small. Just above 186°K the mean reorientation frequency exceeds 3×10^7 c/s. A final narrowing of the line between 220 and 240°K is thought to be due to vacancy diffusion of the molecules within the lattice, causing the intermolecular contribution to the second moment to vanish also. Details are given of the gas-flow cryostat used in this work. The theoretical formulation of the second moment has been extended to include the modification of the intermolecular contribution during reorientation. A.

539.133

4268. The molecular structure of carbon tetrafluoride. C. W. W. Hoffman and R. L. Livingston. Letter in *J. chem. Phys.*, **21**, 565 (*March*, 1953).

The length of 1·36 Å for the C–F bond of CF_4, as reported in literature, seems too large in view of several data for CHF_3, CH_2F_2 and CH_3F. Electron diffraction measurements were carried out and a more reasonable C–F length of 1·31$_7$ Å was found.

A. J. TAYLOR

ATOMIC STRUCTURE . NUCLEUS
ISOTOPES 539.15

539.152.1

4269. Looking into the nucleus. F. Bitter. *J. Opt. Soc. Amer.*, **43**, 233–6 (*April*, 1953).

This paper provides a brief elementary account of the insight into nuclear structure which has been obtained from investigations of the hyperfine structure of atomic energy levels. A.

539.152.1

4270. Nuclear stability rules. N. Feather. *Cambridge: Cambridge University Press* (1952) 162 *pp.* [*Cambridge Monographs on Physics*].

Review in *Phil. Mag.*, **44**, 231–2 (*Feb.*, 1953).

539.152.1

4271. On closed proton shells in nuclei of atomic number less than fifty. S. Sengupta. Letter in *Curr. Sci.*, **21**, 272–3 (*Oct.*, 1952).

Plots against Z of the number of stable isotopes and the energy released on the addition of a proton provide some evidence for sub-shells at 8, 16, 20, 28, 34, 42, 50.

W. J. SWIATECKI

539.152.1

4272. Relative energy levels of some *P* shell nuclei in intermediate coupling. E. A. Crosbie. *Phys. Rev.*, **90**, 138–42 (*April* 1, 1953).

The relative energy levels of the low states for configurations consisting of 2, 3, 4, 8, 9 and 10 nucleons in the P shell are shown for all values of the spin orbit to interaction energy ratio by means of second-order perturbation calculations in both extreme coupling schemes. The interaction potential is assumed to be a linear combination of ordinary, and space, spin, and charge exchange terms. Coulomb forces are ignored so that the charge quantum number T is a constant of the motion. Comparison is made with the first few excited states of some light nuclei. There is some evidence that the spin orbit energy is relatively more important for N^{14} than for Li^6. A.

539.152.1

4273. The 2$^+$ first excited state in heavy even-even nuclei. A. H. Wapstra. Letter in *Physica*, **18**, 799 (*Oct.*, 1952).

A table of experimental values is given, showing the excitation energy of this state to be a smooth function of the number of nucleons, with a maximum at the crossing of the magic numbers $N = 126$, $Z = 82$. Existence of this low excited state in nuclei $A > 220$ is stated to give rise to the fact that the α-decay to these nuclei is a mixture of two α-transitions. The calculated value of the relative intensities of these α-transitions is in reasonable agreement with that observed experimentally. J. HUGHES

539.152.1

4274. Excited states of nuclei in *jj*-coupling. B. H. Flowers. *Physica*, **18**, 1101 (*Dec.*, 1952).

A brief account is given of the classification of states arising from a configuration j^n of neutrons and protons in jj-coupling with short-range central interactions, and evidence is brought to suggest that the classification has experimental confirmation. On the basis of the new classification it is possible to lay down certain approximate selection rules for radiative transitions. Some of these rules are discussed. A.

539.152.1

4275. The first excited states of even-even nuclei. K. W. Ford. *Phys. Rev.*, **90**, 29–44 (*April* 1, 1953).

The collective model of the nucleus, as expressed in A. Bohr's strong coupling approximation, is applied to the low levels of even-even nuclei. It yields the correct level order of the first few states, and predicts the qualitative regularities of the first excited energy surface which are observed experimentally. The approximation is shown to be much better for two or more extra nucleons than for one, but the first excited energy spacing is sensitive to second-order corrections even for many extra nucleons. Predicted nuclear distortions are larger than is reasonable (*a*) in the rare earth group, and (*b*) near doubly magic Pb^{208}. An empirical way to correct for this discrepancy is to diminish the particle-to-surface coupling coefficient. A simple formula is given for computing an upper limit to the nuclear distortion from the first excited [illegible] of even nuclei. After correction by a single [illegible]ble parameter, this formula yields a fair correlation with quadrupole moments and a better correlation with isotope shifts in the region $50 < N < 126$. The energy level behaviour beyond Pb gives a prediction of quadrupole moment and isotope shift behaviour for $N > 126$. Certain regularities in the [illegible]s of odd-even nuclei are also predicted. A.

539.152.1 : 539.163

4276. Classification of nuclear isomers. M. GOLDHABER. *Physica*, **18**, 1091–3 (*Dec.*, 1952).

The progress made during the last few years permits a definite classification of many nuclear γ-ray transitions according to their multipole character. This classification yields matrix elements for γ-transitions which can be compared with calculations based on the one particle model. For electric transitions, just as for β-transitions, deviations from the simple model show up through the "scatter" of the matrix elements. Magnetic transitions, however, have surprisingly uniform matrix elements. In many cases the energy differences of levels of known spin vary in a regular manner from nucleus to nucleus. For a discussion of these regularities the language of shell theory proves useful. A.

539.152.2

4277. On a question of nuclear spectroscopy. A. GAMBA AND M. VERDE. Letter in *Nuovo Cimento*, **9**, 544–6 (*June*, 1952).

Formulae, valid for *L-S* and *j-j* coupling, are derived for the multiplicities N_J of the angular momentum J associated with a given term of n equivalent nucleons for $n = 3, 4$ and any j. W. J. SWIATECKI

539.152.2

4278. Relativistic corrections to the magnetic moments of nuclear particles. G. BREIT AND R. M. THALER. *Phys. Rev.*, **89**, 1177–86 (*March* 15, 1953).

A re-examination of the problem is reported. The results for the vector and scalar cases in the case of the deuteron are explained in terms of known correction factors for the one-body problem. For the vector equation part of the result is caused by an induction effect which is the meson theoretic generalization of Faraday's law of induction. In the scalar case the relation to the one-body result is made in a form employing an effective change in mass caused by the presence of the scalar. These interpretations are substantiated by an analysis in terms of plane waves. Simple forms are obtained for one particle in a pseudoscalar field and a tentative application to the deuteron is made and criticized. A.

539.152.2

4279. The nuclear spins and magnetic moments of ^{24}Na, ^{42}K, ^{86}Rb, ^{131}Cs and ^{134}Cs. E. H. BELLAMY AND K. F. SMITH. *Phil. Mag.*, **44**, 33–45 (*Jan.*, 1953).

The atomic beam magnetic resonance method has been used to find the nuclear spins and the ground state hyperfine structure splittings of the radioactive alkali atoms Na^{24}, K^{42}, Rb^{86}, Cs^{131} and Cs^{134}. The spins and $\Delta\nu$ values were obtained by observing $\Delta F = 0$, $\Delta m = \pm 1$ transitions in weak and intermediate fields, and the Fermi–Segre relation was used to calculate the magnetic moments from the results. More accurate $\Delta\nu$ values were also found for Na^{24} and K^{42} by locating $\Delta F = \pm 1$, $\Delta m = \pm 1$ transitions. The results are tabulated below.

	I	h.f.s. (Mc/s)	μ (nm)
Na^{24}	4	$1139{\cdot}35 \pm 0{\cdot}10$	$+1{\cdot}688 \pm 0{\cdot}005$
K^{42}	2	$1258{\cdot}9 \pm 0{\cdot}1$	$-1{\cdot}137 \pm 0{\cdot}005$
Rb^{86}	2	3960 ± 20	$-1{\cdot}69 \pm 0{\cdot}01$
Cs^{131}	5/2	$13\,200 \pm 110$	$+3{\cdot}48 \pm 0{\cdot}04$
Cs^{134}	4	$10\,440 \pm 30$	$+2{\cdot}95 \pm 0{\cdot}01$

A.

539.152.2

4280. Nuclear spin and magnetic moment of radioactive cobalt 57. J. M. BAKER, B. BLEANEY, K. D. BOWERS, P. F. D. SHAW AND R. S. TRENAM. Letter in *Proc. Phys. Soc.* [*London*] *A*, **66**, 305–6 (*March*, 1953).

From h.f.s. observations $I = 7/2$, $\mu = 4{\cdot}6 \pm 0{\cdot}2$ n.m. Co^{57} and Co^{59} have the same spin and almost identical magnetic moments. L. PINCHERLE

539.152.2

4281. "Core isomerism"—remarks on Mo^{93m}. M. GOLDHABER. Letter in *Phys. Rev.*, **89**, 1146–7 (*March* 1, 1953).

It is suggested that Mo^{93m}, which behaves in some respects as if it were an even-even nucleus, is a case of "core isomerism," an excitation of the even-even core to a high spin state (probably 8+, which may be obtained by breaking a $g_{9/2}$ pair of protons and putting one of the protons into a $g_{7/2}$ state; if the odd neutron remains in a $g_{7/2}$ state throughout the three-step core isomeric transition, the spin of Mo^{93m} may be as high as 23/2+). A. O. STANESBY

539.152.2

4282. Nuclear magnetic moment of Pr^{141} from the hyperfine structure of Pr II. P. BRIX. *Phys. Rev.*, **89**, 1245–6 (*March* 15, 1953).

From the hyperfine structure of Pr II lines measured by White the magnetic interaction constant $a_{6s} = 0{\cdot}416 \pm 0{\cdot}015\ cm^{-1}$ has been evaluated for the $6s$ electron in the configuration $4f^3(^4I)6s$. Application of the formula of Goudsmit and Fermi–Segrè yields the nuclear magnetic moment $\mu(Pr^{141}) = +3{\cdot}9 \pm 0{\cdot}3$ nuclear magnetons. A.

539.152.2

4283. Magnetic moments of odd-odd nuclei and the strong spin-orbit coupling shell model. H. M. SCHWARTZ. *Phys. Rev.*, **89**, 1293–4 (*March* 15, 1953).

Using the extreme *jj* coupling model and employing semi-empirical g factors, magnetic moments are computed for those odd-odd nuclei for which I and μ measurements exist. The results are suggestive as to relevant coupling properties of such nuclei, but as yet not sufficient for definite conclusions. As an aid to possible future work, this note includes a tabulation of computed magnetic moments for some odd-odd nuclei for which tentative spin assignments are possible, employing both free nucleon and semi-empirical g factors and based on pure *LS* and *jj* two-nucleon states. A.

539.152.2

4284. Geometrical solution for a nuclear moment in a magnetic field. R. K. WANGSNESS. *Amer. J. Phys.*, **21**, 274–6 (*April*, 1953).

The general solution of the classical equation of motion $d\boldsymbol{\mu}/dt = g(\boldsymbol{\mu} \times \mathbf{H})$, when $\mathbf{H}$ consists of a constant field plus a perpendicular rotating component, can easily be obtained after transforming the problem to a properly chosen rotating co-ordinate system. The value of this method for teaching purposes is discussed. A.

539.152.2

4285. Effects of departures from the single particle model on nuclear magnetic moments. A. DE-SHALIT. *Phys. Rev.*, **90**, 83–6 (*April* 1, 1953).

Departures from the single particle model (SPM) are considered, in which the SPM wave function is

mixed with others representing states for which the core no longer has zero momentum. It is found that under certain restrictions an experimentally established relation exists between the deviations of odd-N nuclei from the Schmidt lines and those of odd-Z nuclei. A.

539.152.2

4286. The hyperfine structure of the $3p\ ^2P_{\frac{1}{2}}$ state of Al^{27}. Hin Lew and G. Wessel. *Phys. Rev.*, **90**, 1–3 (*April* 1, 1953).

The h.f.s. interval found to be $1506 \cdot 14 \pm 0 \cdot 05$ Mc/s. From this datum and the known h.f.s. of the $3p^2P_{\frac{3}{2}}$ state a recalculation of the nuclear electric quadrupole moment, taking into consideration configuration interaction, yields the value $Q = +0 \cdot 149 \times 10^{-24}$ cm^2. A.

539.152.2 : 538.22

4287. Magnetic resonance. I. Nuclear magnetic resonance. II. Magnetic resonance of electrons. K. K. Darrow. *Bell Syst. tech. J.*, **32**, 74–99 (*Jan.*); 384–405 (*March*, 1953).

An extremely clear and readable review for non-specialists. Pt II covers the phenomena usually known as paramagnetic and ferromagnetic resonance.

539.152.2 : 539.166

4288. Nuclear alignment in isotopes of cobalt. M. A. Grace and H. Halban. *Physica*, **18**, 1227–34 (*Dec.*, 1952).

A significant anisotropy of γ-radiation from aligned Co^{60} nuclei has been detected. From the variation of the anisotropy with temperature a value for the magnetic moment can be determined: this is $3 \cdot 5 \pm 0 \cdot 5$ nuclear magnetons and is consistent with the Schmidt limit of $3 \cdot 8$ based on nuclear shell model assignments. Similar investigation of Co^{58} shows that the γ-ray cannot be dipole but is probably quadrupole. This would give a value of μ of $3 \cdot 5$ which is smaller than the Schmidt limit of $6 \cdot 2$. A.

539.152.2 : 539.166

4289. Anisotropic angular distribution of gamma radiation emitted by a source containing aligned ^{60}Co nuclei. O. J. Poppema, J. A. Beun, M. J. Steenland and C. J. Gorter. *Physica*, **18**, 1235–40 (*Dec.*, 1952).

The anisotropic angular distribution of the γ-radiation from aligned Co^{60} nuclei has been measured as a function of the magnetic temperature T^* of a source, consisting of six (Co 1%, Cu 10%, Zn 89%) $(NH_4)_2(SO_4)_2.6H_2O$ single crystals. The angular distribution has been determined from $T^* = 0 \cdot 02°$ to $T^* = 0 \cdot 08°$. The maximum anisotropy at $T^* = 0 \cdot 02°$ is 30%. The experimental results are in reasonable agreement with the theory if we assume the angle 2α between the two axes of nuclear alignment to have the value of 72°. The scintillation counter device and the counting technique are briefly described. The anisotropy effect does not strongly depend on the amount of copper, used as a cooling agent in the crystals. With 20% Cu a somewhat larger anisotropy could be achieved. A.

539.153

4290. Lifetimes of metastable states of noble gases. A. V. Phelps and J. P. Molnar. *Phys. Rev.*, **89**, 1202–8 (*March* 15, 1953).

The lifetimes of the lower metastable states of helium, neon and argon have been studied as a function of the pressure and temperature of the parent gas and the size of the container. The lifetimes were determined from measurements of the decay constant of the radiation absorbed by the metastable atoms. At low metastable concentrations the loss is by diffusion to the walls of the absorption cell and by collisions with neutral atoms within the volume of the cell. The data indicate that at 300°K and sufficiently high pressures, the volume destruction of the lower neon metastable is directly proportional to the pressure as expected for two-body collisions. The volume destruction of the lower neon metastables at 77°K and the helium triplet metastables at 300°K and 77°K is proportional to the square of the pressure as for three-body collisions. The volume loss of the lower argon metastables at 300°K contains both linear and quadratic pressure dependent terms. A.

539.153

4291. The effect of temperature on the duration of the $^3P_2$ metastable level of neon. F. A. Grant and A. D. Krumbein. *Phys. Rev.*, **90**, 59–62 (*April* 1, 1953).

Using the light absorption method, the duration of the $^3P_2$ metastable level of Ne has been measured as a function of pressure at the temperatures of boiling water, ice, dry-ice/alcohol and liquid N. At pressures below 1 mm Hg departure from Zemansky's formula is found only at the temperature of liquid N, while at pressures above 2 mm departures are found at all temperatures. A.

539.153

4292. Ortho-parapositronium conversion. A. Ore. *Univ. Bergen Årbok*, **1949**, *No.* 12, 13 *pp.*

Transitions between the 1^3S and the 1^1S states of atomic positronium could conceivably influence the lifetime observed for slow positrons in gases. It is shown, however, that such transitions are unimportant, whether considered as resulting from perturbations or electron exchange by collisions of positronium atoms with gas molecules, or as induced by the radiation field. A.

539.153

4293. Stability of simple positron compounds. A. Ore. *Univ. Bergen Årbok*, **1952**, *No.* 5, 33 *pp.*

The possible dynamical stability of certain positron compounds is investigated variationally. The systems at issue consist of one or more electrons, one ordinary atomic nucleus and one positron. The merits of various types of trial wave functions are compared. The particular positron compound e^+H^-, the positronium hydride molecule, is studied extensively. The paper includes calculations reported previously to establish the dynamical stability of this structure, by yielding the lower limit of approximately 0·07 eV for the dissociation energy. The method of calculation employed in this case is essentially the one which has been known to suffice for establishing the stability of the positronium molecule [Abstr. 1586, 2604 (1947)]. This method was previously described in a very sketchy manner and in a way which did not reveal its full range of applicability. A.

539.153 : 535.338.332

4294. New fine structure in neutral oxygen. L. W. Parker and J. R. Holmes. *Phys. Rev.*, **90**, 142–4 (*April* 1, 1953).

Untabulated fine structure in O I has been resolved

in the triplet multiplets $\lambda 8446(3s\,^3S_1 - 3p\,^3P_{210})$, $\lambda 2884(3p\,^3P_{21} - 3d'\,^3P_3)$, and $\lambda 4368(3s\,^3S_1 - 4p\,^3P_{210})$. Interferometer patterns of these lines were analysed to obtain splittings and relative intensities. Listed as a doublet, $\lambda 8446$ has three components whose relative intensities allowed establishment of the $3p\,^3P_{210}$ anomalous splitting as follows: $J = 1$ lies $0{\cdot}559$ $(\pm 0{\cdot}003)$ cm^{-1} below $J = 2$, and $J = 0$ lies $0{\cdot}158$ $(\pm 0{\cdot}002)$ cm^{-1} above $J = 2$, in agreement with Edlén. $\lambda 2884$, heretofore found single, has two components, separated by $0{\cdot}558(\pm 0{\cdot}002)$ cm^{-1}. Two components of $\lambda 4368$, previously considered single, were resolved and found to have a separation of $0{\cdot}300(\pm 0{\cdot}001)$ cm^{-1}, the weaker component having the shorter wavelength. From the relative intensities it is deduced that $J = 0$ lies above the degenerate $J = 2$, 1 level of the state $4p\,^3P_{210}$, which, like $3p\,^3P_{210}$, is perturbed by an unobserved state in the displaced (^2D) system. A.

539.153.4

4295. Electronic wave functions. IX. Calculations for the three lowest states of the beryllium atom. S. F. Boys. *Proc. Roy. Soc.*, **217**, 136–50 (*March* 24, 1953).

For Pt VIII, see Abstr. 7489 (1952). The investigation described here has provided wave functions for the lowest S^1, P^1 and P^3 states of the Be atom which are more accurate according to the energy test than any wave functions reported previously for these states. The first is an improvement on a previous result by the author, and the other two on results by Hartree and Hartree (1936). The calculations were performed by the poly-detor variational method using exponential functions, and they provided an opportunity to test particular procedures for the choice of elementary functions and detors. The wave functions will be valuable for the calculation of atomic properties, but a simple examination is sufficient to show interesting characteristics such as the occurrence of various types of electronic positional correlation. In the calculation various theorems and formulae were established, and these will be useful for further calculations on the same states and also for calculations on many more complicated atomic states. A.

539.153.4

4296. Studies of atomic self-consistent fields. I. Calculation of Slater functions. P.-O. Löwdin. *Phys. Rev.*, **90**, 120–6 (*April* 1, 1953).

A refined technique is described for approximating the numerically given radial part of atomic wave functions associated with self-consistent fields with exchange by means of Slater's analytical functions obtained by replacing each exponential in a hydrogen-like wave function by the sum of one, two, three or more exponentials. Exponents and coefficients of these exponentials are calculated for the $3p$-function of Cl^-, corresponding to an accuracy of $0{\cdot}0015$ for the normalized radial part, and, with slightly less accuracy, for all the functions of two closed-shell ions, F^- (without exchange) and Na^+, and for some neutral first-row atoms, $C(^1D)$, $N(^2P)$ and $O(^1S)$. The interpolation problem is discussed, and a new interpolation rule for the coefficients is stated, which gives excellent agreement $(0{\cdot}001)$ in the examples chosen, namely the $1s$-functions of the He-like ions and the $2p$-functions of Na^+, Mg^{+2} and Si^{+4}. A.

539.155.2

4297. Hydrogen isotopes in steam wells. G. Boato, G. Careri and G. G. Volpi. Letter in *Nuovo Cimento*, **9**, 539–40 (*June*, 1952).

The steam from the fumaroles of Larderello was found to have the same isotopic ratio (D/H) as tap water. The hydrogen gas, present in quantity of 1/1000 or less of the steam, had an enrichment factor of $0{\cdot}79 \pm 0{\cdot}05$. This deuterium deficiency could be caused either by diffusion separation in the earth, or in an exchange reaction with the steam. F. R. HOLT

RADIOACTIVITY . α-, β- AND γ-RAYS 539.16

539.163

4298. Radioactive cobalt laboratory for chemical research. R. A. Blomgren, E. J. Hart and L. S. Markheim. *Rev. sci. Instrum.*, **24**, 298–303 (*April*, 1953).

The essential features of two Co^{60} γ-ray irradiation chambers designed primarily for chemical studies are described. The "multisource chamber," holding up to a maximum of five separate Co^{60} sources in a movable shield mounted on top of the chamber, is designed basically for studies on the effect of dosage rate. Up to a total of 100 curies of cobalt activity may be housed in this chamber. The "double cavity irradiation chamber" is provided with a single 400 curie Co^{60} source which may be lowered into either of two irradiation cavities. One of these cavities is a thermostated well that may be maintained at constant temperatures in the range from −30°C to 130°C. Two intermittent γ-ray devices are also described. A.

539.163

4299. A search for Si^{32} in natural silicon. A. Turkevich and A. Tompkins. *Phys. Rev.*, **90**, 247 (*April* 15, 1953).

Two samples of quartz that had been exposed to an intense neutron flux have been examined radiochemically for the presence of 25-day P^{33}. Only P^{32}, formed presumably from impurities, has been found. Using the limits of detectability and analysis conditions and assuming $0{\cdot}05$ barn for the neutron capture cross-section of Si^{32}, an upper limit of 4×10^{-6}% results for the abundance of Si^{32} in natural Si. A.

539.163.2

4300. Identification of the seven-hour Mo^{93} isomer. D. E. Alburger and S. Thulin. Letter in *Phys. Rev.*, **89**, 1146 (*March* 1, 1953).

The 7 hr Mo isomer, obtained by deuteron bombardment of Nb metal targets, was identified directly as Mo^{93} using an isotope separator. The internal conversion electron and γ-ray spectra were examined in a double-focusing spectrometer; the energy of the lifetime-determining transition is $263{\cdot}7 \pm 1{\cdot}0$ keV, with a $K/(L + M)$ ratio of $2{\cdot}79 \pm 0{\cdot}15$, and the energies of the 2 following cascade γ-rays are $0{\cdot}685 \pm 0{\cdot}003$ and $1{\cdot}479 \pm 0{\cdot}005$ MeV, giving a total decay energy of $2{\cdot}428 \pm 0{\cdot}006$ MeV.

A. O. STANESBY

539.163.2

4301. Molybdenum 90. R. M. DIAMOND. Letter in *Phys. Rev.*, **89**, 1149–50 (*March* 1, 1953).

A Mo activity of ½-life 5·7 ± 0·2 hr was separated from the high-energy proton spallation products of Nb, and assigned to Mo^{90}; the disintegration scheme involves predominantly 3 γ-rays with energies 1·1, 0·24–0·26 and 0·10–0·13 MeV, and positrons of max. energy ~1·4 MeV. A. O. STANESBY

539.163.2

4302. Heavy isotopes of magnesium and silicon. M. LINDNER. Letter in *Phys. Rev.*, **89**, 1150 (*March* 1, 1953).

After bombardment with 340 MeV protons, a NaCl target contained a 21 hr (β and γ) activity attributed to Mg^{28}. No evidence for a Si^{32} isotope could be found. J. J. WILKINS

539.163.2

4303. Assignment of Y^{92} and Y^{94}. G. L. SCHOTT AND W. W. MEINKE. Letter in *Phys. Rev.*, **89**, 1156–7 (*March* 1, 1953).

The mass assignments of the 16·5 min (Y^{94}) and 3·5 hr (Y^{92}) yttrium activities are strongly supported by measurements of the relative bombardment yields of Y^{90}, Y^{92} and Y^{94} prepared by the $Zr(d, \alpha)$ reaction, assuming equal yields for all the (d, α) reaction products from the even-even isotopes of Zr, and no isomeric states in Y^{90}, Y^{92} nor Y^{94}. A. O. STANESBY

539.163.2

4304. The radioactive decay of tungsten 187. J. M. CORK, M. K. BRICE, W. H. NESTER, J. M. LEBLANC AND D. W. MARTIN. *Phys. Rev.*, **89**, 1291–2 (*March* 15, 1953).

Using sources derived from neutron capture in enriched (97·5%) W^{186}, about 40 internally converted electron lines are recorded in photographic magnetic spectrometers. Their interpretation leads to the evaluation of 14 γ-rays in Re^{187}, 7 of which had not been previously observed. It is possible to arrange these transitions in a consistent level scheme for the Re^{187} nucleus. The K/L ratios are determined for 5 of the γ-rays and the multipolarity and nature of the transitions proposed. A.

539.163.2

4305. Radiations of Pu^{243}. D. W. ENGELKEMEIR, P. R. FIELDS AND J. R. HUIZENGA. *Phys. Rev.*, **90**, 6–10 (*April* 1, 1953).

The radiations of Pu^{243} were studied with β- and γ-scintillation spectrometers alone and in coincidence. An incomplete disintegration scheme is deduced which leads to a total β-disintegration energy of 560 keV. A half-life of 4·98 ± 0·02 hours was observed. A.

539.163.2

4306. Radioactivity of Pt^{191} and Pt^{193m}. J. B. SWAN, W. M. PORTNOY AND R. D. HILL. *Phys. Rev.*, **90**, 257–8 (*April* 15, 1953).

A 3·2-day activity of Pt^{191} and a 4·5-day activity of Pt^{193} have been investigated. Electron-capture of Pt^{191} is followed by a complex spectrum of γ-radiation. The 4·5-day Pt^{193m} activity is a characteristic $M4$ isomeric transition of 135 keV. A.

539.163.2

4307. A search for short-lived nuclear isomers. T. C. ENGELDER. *Phys. Rev.*, **90**, 259–60 (*April* 15, 1953).

A search for short-lived isomeric transitions has been initiated. Using a delayed coincidence apparatus having an over-all resolution of 2×10^{-9} sec, 16 γ-transitions were investigated for half-lives in the 2×10^{-9} to 10^{-7} sec range. Metastable states in K^{41}, 1·3 MeV above ground and in Ta^{181}, 471 keV above ground were verified, while the remaining transitions were found to have half-lives less than 2×10^{-9} sec. Weisskopf's formula relating spin change and half-life, together with internal conversion information, were applied to these data, and definite spin changes were assigned to 5 of the transitions. A.

539.163.2

4308. The alpha-branching of AcK and the presence of astatine in nature. E. K. HYDE AND A. GHIORSO. *Phys. Rev.*, **90**, 267–70 (*April* 15, 1953).

Making use of the predictions of "alpha systematics" on the extent of α-branching of the isotope AcK and of the properties of the resultant At^{219} daughter, the branching was looked for and found in the francium fraction isolated from a 20 mc source of Ac^{227}. The observed branching rate is $\sim4\times10^{-5}$, and the At^{219} daughter decays predominantly by the emission of 6·27 MeV α-particles with a half-life of 0·9 min to the new isotope Bi^{215}, which in turn emits β^- particles with a half-life of 8 min. At^{219} also decays by β^- emission to An^{219} about once in 30 disintegrations. It is pointed out that this is the first reported instance of a chemical identification of an isotope of element 85 from a natural source, although other shorter-lived astatine isotopes are known to exist. A.

539.164.75

4309. An undergraduate experiment for the determination of alpha-particle range. W. C. MICHELS AND E. WIENER. *Amer. J. Phys.*, **21**, 307–9 (*April*, 1953).

Simple apparatus, using a scintillation counter with a 931-A photomultiplier, is described. The range of α-particles from Po^{210} is determined with this apparatus by varying the pressure in a shielded container, keeping the geometry constant. Data are presented on a 0·06 millicurie source, yielding a range of (3·81 ± 0·03) cm at 760 mm Hg and 15°c. This value is obtained after correction for finite source thickness. The experiment offers particular value in giving students an opportunity to consider statistical fluctuations and to analyse the effects of finite source thickness, straggling, etc. A.

539.165.08

4310. Absolute beta counting of thick planar samples. R. G. BAKER AND L. KATZ. *Nucleonics*, **11**, 14–19 (*Feb.*, 1953).

Experimental investigations into the influence of self-absorption and self-scattering on β-particle counting rate, obtained with thick uniform samples, are described. The self-absorption measurements were carried out with various β-emitters of varying thicknesses, using 4π geometry to eliminate the effects of self-scattering. An empirical expression, relating the absorption coefficient to the β-ray end-point energy, is given. Self-scattering experiments were carried out

in an end-window counter with a small aperture. The angular distribution of β-particles leaving a plane source are given for different source thicknesses.

L. R. SHEPHERD

539.165.2

4311. On the theory of forbidden beta-transitions. R. H. GOOD, JR. *Univ. Microfilms Publ. No.* 2597 (1951) 86 *pp.* (Photo-reproduction.)

Abstract in *Microfilm Abstracts*, **11**, No. 3, 708–9 (1951).

539.165.2

4312. Beta disintegration, allowed and forbidden decay. C. S. WU. *Physica*, **18**, 989–1010 (*Dec.*, 1952).

The determination of the fundamental β-decay interaction from the evidence on lifetime and spectrum shape for allowed and forbidden β-decay and on β-γ and electron-neutrino (nuclear recoil) angular correlation is surveyed and discussed. It is concluded that the combinations (S, T), (V, A) and (V, T) (each with unknown P-admixture) are still allowed by the data, but that reliable nuclear recoil experiments will aid in deciding between them. R. H. DALITZ

539.165.2

4313. Interference terms and symmetry principles in the theory of beta decay with mixed invariants. S. R. DE GROOT. *Physica*, **18**, 1011–12 (*Dec.*, 1952).

Discusses briefly the cross terms which occur in the expressions for the energy spectrum, for β-neutrino angular correlation and for β-particle polarization from oriented nuclei, when the β-decay interaction is a linear combination of the usual five four-fermion interactions. R. H. DALITZ

539.165.2 : 539.166

4314. On the theories of angular distribution and correlation of beta and gamma radiation. S. R. DE GROOT. *Physica*, **18**, 1201–14 (*Dec.*, 1952).

In both phenomena of angular distribution and angular correlation, one has nuclear radiation from ensembles of nuclei with an unequal population of the magnetic sub-levels. This population is described by appropriate "orientation parameters." On this basis the theories of the directional as well as the polarization aspects of angular distribution and correlation are reviewed in this paper. Special attention is paid to the quantum-mechanical description of polarization by means of statistical matrix elements and Stokes parameters. Results and examples are considered especially of the distribution of γ- and β-rays, and the correlation of γ-γ-, β-γ- and β-neutrino radiation. A.

539.165.2 : 539.166

4315. The Fermi term in β-ν correlation. D. C. PEASLEE. Letter in *Phys. Rev.*, **89**, 1148–9 (*March* 1, 1953).

From a survey of mirror image decays of gaseous isotopes, it is concluded that A^{35} is the most suitable isotope for a β-ν (recoil) correlation experiment to determine the Fermi interaction term. J. HUGHES

539.165.2

4316. Radiative corrections to β-decay matrix element. S. KAMEFUCHI. Letter in *Progr. theor. Phys.*, **81**, 137–8 (*July*, 1952).

S-matrix elements for all graphs having four external fermion lines and involving one β-decay interaction (coupling constant g) together with radiative corrections, may be made finite by renormalization of g. R. H. DALITZ

539.165.2

4317. Pseudoscalar matrix element in beta-decay. M. RUDERMAN. *Phys. Rev.*, **89**, 1227–30 (*March* 15, 1953).

The interpretation of the β-spectrum of RaE seems to need a mixture of pseudoscalar and tensor interactions. Estimates of the necessary G_P give $G_P \gg G_T$ to compensate for the small pseudoscalar matrix element. This matrix element is greatly increased if the nucleon is in a potential which strongly mixes free particle states of positive and negative energies even though the diagonal terms are not large. Such an interaction arises from pseudoscalar meson theory. The pseudoscalar matrix element is calculated for the RaE decay assuming that the nucleons interact through pseudoscalar coupled pseudoscalar mesons. Exchange transitions, in which two nucleons exchange the charge and spin given to the electron and neutrino, predominate. The RaE spectrum can be fitted with $G_P \sim -G_T$. Exchange terms alter other momentum type matrix elements appreciably. Such effects are unimportant for gradient coupled pseudoscalar mesons. A.

539.166

4318. Gamma-rays from cadmium 117. A. H. W. ATEN, JR AND M. BOELHOUWER. Letter in *Physica*, **18**, 651 (*Aug.–Sept.*, 1952).

Measurements using lead absorbers indicated an energy of 1·25 MeV, a half-life of 2·9 ± 0·1 hr, and approximately one γ-quantum per β-particle.

J. J. WILKINS

539.166

4319. Low-energy gamma-ray sources. R. WEST. *Nucleonics*, **11**, 20–3 (*Feb.*, 1953).

The preparation of Tm^{170} sources in the form of small high-density sintered oxide cylinders and disks is described. Results obtained, using these sources in radiography and thickness measurements with Al, steel and other materials are given. Am^{241} prepared by pile irradiation of Pu has also been studied for its suitability in the radiography of the human body. The possible employment of Eu^{155} and Xe^{133}, which also yield very low energy γ-rays, is considered.

L. R. SHEPHERD

539.166

4320. γ-radiation from the transition Sn^{113}-In^{113}. Y. DESCHAMPS AND P. AVIGNON. *C.R. Acad. Sci. [Paris]* **236**, 478–80 (*Feb.* 2, 1953) *In French.*

Scintillation counter measurements clearly revealed a 393 keV γ-ray, but set upper limits of 0·01 and 0·1, respectively, to the relative intensities of the 255 keV and 400 keV γ-rays reported by other workers [Abstr. 4647 (1951)]. J. J. WILKINS

539.166

4321. Systematic calculations of gamma-ray penetration. H. GOLDSTEIN, J. E. WILKINS, JR AND L. V. SPENCER. Letter in *Phys. Rev.*, **89**, 1150 (*March* 1, 1953).

Extensive calculations have been carried out using a calculating machine. The scope and form of the results (to be published) are briefly indicated.

J. J. WILKINS

539.166

4322. The gamma-radiation from Am^{241}. J. O. NEWTON AND B. ROSE. Letter in *Phys. Rev.*, **89**, 1157 (*March* 1, 1953).

Further examination, using Kr- and Xe-filled proportional counters [see also Abstr. 6736 (1952)], of the electromagnetic radiations from carrier-free and La-containing sources of Am^{241} indicates that "γ-rays" reported by Browne (unpublished) are actually the $K\alpha$ and $K\beta$ radiations of La and $L\alpha_1$, $L\beta_1$ and $L\gamma_1$ radiations of Am. It therefore appears to be unnecessary to assume the presence of low-lying levels in Np^{237} other than those excited directly by the observed α-particle groups [Abstr. 7512 (1952)]. A. O. STANESBY

539.166

4323. Precision measurement of Co^{60} gamma-radiation. G. LINDSTRÖM, A. HEDGRAN AND D. E. ALBURGER. Letter in *Phys. Rev.*, **89**, 1303–4 (*March* 15, 1953).

Gamma-ray energies of $1{\cdot}3325 \pm 0{\cdot}0003$ MeV and $1{\cdot}1728 \pm 0{\cdot}0005$ MeV are deduced from β-spectrometer measurements. For both lines the $K/(L+M)$ conversion ratio is approximately 10. J. J. WILKINS

539.166

4324. Gamma-rays from Mg^{26}. J. E. MAY AND B. P. FOSTER. *Phys. Rev.*, **90**, 243–7 (*April* 15, 1953).

The energies of the γ-rays found in coincidence with the protons of the $Na^{23}(\alpha, p)Mg^{26}$ reaction have been measured with a NaI(Tl) scintillation counter. The experiments revealed doubt as to the existence of an excited state at 0·4 MeV. A direct transition to ground was found from the 1·83 MeV excited state. Competition between a cascade transition to the 1·83 MeV excited state and a weaker crossover transition to ground was observed for the 2·97 MeV excited state. With the 3·97 MeV excited state were identified a cascade transition to the 1·83 MeV excited state and a probable crossover transition to the ground state. For the decay of the 4·35 MeV excited state, a 1·38 MeV transition to the 2·97 MeV excited state was established. There is also a discussion of possible spin and parity assignments and a few decay schemes proposed by the use of the Weisskopf lifetime formulae. A.

539.166

4325. Electromagnetic radiation from radium E. D. G. E. MARTIN AND G. PARRY. Letter in *Phil. Mag.*, **44**, 344–6 (*March*, 1953).

A scintillation spectrometer has been used to study the electromagnetic radiation from a RaE source, to determine if a monochromatic line exists in the region of 85 keV. It appears that the intensity of such radiation is not greater than 1 quantum per 6000 β-disintegrations. The number of γ-quanta in the bremsstrahlung above 90 keV is estimated to be $2{\cdot}5 \times 10^{-3}$ per disintegration. A.

539.166

4326. Electromagnetic spectrum of radium D. P. E. DAMON AND R. R. EDWARDS. *Phys. Rev.*, **90**, 280–4 (*April* 15, 1953).

The electromagnetic spectrum of RaD has been studied by the proportional counter spectrometry technique. The work of the Curie Laboratory on the γ-ray spectrum has been generally confirmed. However, the presumed K X-ray lines are of much lower intensity and occur at a lower energy than previously reported. The L X-ray intensity is 22 per hundred disintegrations, indicating 0·63 conversion per disintegration and a conversion coefficient of 18·3 for the principal γ-ray. A.

539.166 : 539.152.2

Anisotropic gamma-radiation from aligned nuclei of Co. *See Abstr.* 4288–9

539.166.74

4327. Compton scattering by electrons with a Maxwellian distribution of thermal velocities. F. N. EDMONDS, JR. *Astrophys. J.*, **117**, 298–305 (*March*, 1953).

The theory of the Compton effect is applied to the problem of scattering of radiation by electrons with a Maxwellian distribution of thermal velocities; and a spectral distribution function for scattered radiation is obtained in the second approximation. This function is asymmetric, and the frequency shift of scattered radiation corresponding to this asymmetry is given by $(\nu - \nu')/\nu' = (1 - \cos\theta)(h\nu - 3kT)/m_0c^2$, where ν is the incident frequency, ν' the scattered frequency, θ the angle of scattering and the other symbols have their usual meaning. The red shift in this expression is due to the Compton effect, while the blue shift is a result of the thermal motions of the electrons, as first pointed out by Dirac. A.

539.166.83

4328. Experimental K to $L + M$ ratios for internal conversion lines. R. E. MAERKER AND R. D. BIRKHOFF. Letter in *Phys. Rev.*, **89**, 1159 (*March* 1, 1953).

Measurements on γ-rays from Cs^{134}, Cs^{137}, Nb^{95}, Sb^{124}, Ba^{140} and La^{140} are reported. J. J. WILKINS

539.166.832

4329. Some notes on collimated Compton spectra. D. G. E. MARTIN AND G. PARRY. *Physica*, **18**, 1157–60 (*Dec.*, 1952).

Discusses the arrangement of a 180° β-spectrometer to give a low background for the study of Compton electrons ejected from a target by a collimated beam of γ-rays. The effects of scattering at those spectrometer walls which do not lie within the shadows cast by its defining slits have been investigated. The importance of scattering of electrons at these walls is shown. An arrangement giving a low background counting rate which varies only slowly with energy setting is described. A.

539.166.832/.835

4330. Total Compton and pair production cross sections at 19·5 MeV. A. I. BERMAN. *Phys. Rev.*, **90**, 210–17 (*April* 15, 1953).

Total cross-sections of 19 elements were measured at 19·5 MeV by the photonuclear detector method. The penetration of betatron bremsstrahlung (maximum energy, 20·4 MeV) through the absorbers was determined by the $C^{12}(\gamma, n)C^{11}$ reaction (threshold, 18·7 MeV) in polyethylene. Simultaneously operated monitor-detector Geiger units, which cancelled timing and intensity fluctuation errors, recorded the carbon-11 activity. Percent standard deviations averaged 0·6

for most elements; the estimated systematic error was 0·4%. The narrow energy band width permitted an accurate calculation of the correction for the proportion of counts due to secondary radiation. From the absorption data a value of the Compton cross-section was determined. The integrated Klein–Nishina result fell within the 2% experimental error calculated by adding linearly to the statistical errors, an estimated 50% uncertainty in the published photonuclear cross-sections employed in the determination. The cross-sections for pair production found from the experiment σ_e, are related to the theoretical values σ_t, as derived by the Born approximation (Bethe–Heitler formula including screening), by $(\sigma_t - \sigma_e)/(\sigma_t = (1{\cdot}55 \pm 0{\cdot}1)\times 10^{-5}Z^2$, to a first approximation. A.

539.166.835

4331. Angular separation of electron pairs. I. B. McDiarmid. Letter in *Canad. J. Phys.*, **31**, 337–8 (*Feb.*, 1953).

Projected angles of separation have been measured for pairs produced by γ-rays of up to 70 MeV energy. Distributions and mean values of these angles are plotted as functions of (total) pair energy.

J. J. WILKINS

539.169

4332. Effects of radioactive disintegrations on inner electrons of the atom. J. S. Levinger. *Phys. Rev.*, **90**, 11–25 (*April* 1, 1953).

The probability that nuclear emission of an α- or β-particle causes ionization of a K or L electron of the atom is calculated by time-dependent perturbation theory using non-relativistic Coulomb wave functions. β-Emission (electron or positron) causes an ionization probability of $0{\cdot}64/Z^2$ and $2{\cdot}1/Z^2$ per β in the K and L shells, respectively. (The K shell result agrees with Migdal and Feinberg; the L shell result disagrees with Migdal.) The use of non-relativistic wave functions causes an appreciable underestimate in the ionization probability for K electrons of heavy atoms. Screening corrections for the use of Coulomb wave functions would increase the ionization probabilities by a factor of 1·4 for K electrons and by a factor of 3 or 4 for L electrons. Migdal's result for dipole electronic transitions caused by nuclear α-decay are reduced by a factor 25 (for the case of Po^{210}) because of nuclear recoil. Quadrupole matrix elements such as $(r^{-3})_{1s,n'd}$ are evaluated by a new method developed by H. A. Bethe. This method uses the Sommerfeld integral representation for the continuum $n'd$ wave function. Quadrupole transitions are negligible for K electrons, but are the predominant effect for L electrons. The calculated ionization probabilities for Po^{210} are 10^{-7} and $1{\cdot}1\times 10^{-4}$ per α in the K and L shells, respectively. For α-decay, screening corrections and higher multipole transitions would both increase the ionization probability for L electrons. Madansky and Rasetti's measurements of photons from RaE are consistent with these calculations, but Bunner's measurements on Sc^{44} are not. Grace's interpretation of K X-rays from Po^{210} is consistent with the calculation of this paper, while Barber and Helm's interpretation is not. Rubinson and Bernstein find 8 times the L X-ray yield from Po^{210} calculated here for Coulomb wave functions. A.

539.169 : 614.8

4333. Symposium on the handling of radioactive and toxic substances. *Atomic Energy Res. Establ.* [*Harwell*] *Rep. C/R958* (*March* 3, 1952).

539.169

4334. Ion-exchanging surfaces in radiological decontamination. E. W. Jackson and L. Garrard. Letter in *Nature* [*London*] **171**, 442 (*March* 7, 1953).

Experiments have shown that unplasticized polystyrene has a very low adsorption for fission elements, and may be more completely decontaminated (by elutriation) than a cation-exchanging material such as sulphonated polystyrene. J. J. WILKINS

NUCLEAR REACTIONS 539.17

539.17

4335. Theoretical nuclear physics. J. M. Blatt and V. F. Weisskopf. *New York: John Wiley*, 864 *pp.*

Review in *Phil. Mag.*, **44**, 356 (March, 1953): "Deals mainly with the physics of nuclear processes involving energies less than about 50 MeV, a notable exception being the analysis of *n-p* and *p-p* scattering up to energies of 350 MeV. It is essentially, and in the best sense, an elementary book, dealing more with the broad physical principles of nuclear physics than with detailed mathematical solutions; nevertheless, several sections are devoted to more mathematical aspects of the theory. There is full discussion of the experimental data, and some of the interpretation has not been published elsewhere."

539.17

4336. The energy of nucleon-nucleon collisions. R. G. Glasser and M. Schein. *Phys. Rev.*, **90**, 218–21 (*April* 15, 1953).

The problem of determining the energy of the primary particle in a nucleon-nucleon collision at extremely high energies is discussed. A new nomographic method is proposed which is less subject to fluctuations than most estimates used previously. The method allows a redetermination of the energy of the "*S*" star, which confirms the previous estimate. A.

539.17 : 537.591.1

4337. High-energy nuclear physics. B. T. Feld. *Nucleonics*, **11**, 42–5, 60 (*Feb.*, 1953).

An account of discussions, during a conference at the University of Rochester (December, 1952), dealing with the theory of nuclear forces, interactions between π-mesons, nucleons and photons, and unstable particles observed in cosmic-ray investigations.

L. F. SHEPHERD

539.172 : 537.591.8

Nuclear reactions due to cosmic rays. *See Abstr.* 4185–6, 4193–8

539.172

4338. Interaction of π-mesons with nuclear matter. E. Clementel. Letter in *Nuovo Cimento*, **9**, 369–71 (*April*, 1952) *In Italian.*

The "optical constants" of carbon nuclei for meson waves are calculated to obtain the scattering cross-section as a function of the average potential acting on the meson inside the nuclear matter. L. PINCHERLE

539.172

4339. Nuclear capture of the μ-meson. P. BUDINI. Letter in *Nuovo Cimento*, **9**, 445–8 (*May*, 1952) *In Italian.*

A contribution to the problem whether this is a direct process or occurs through a field interaction. An indirect process implies the existence of the so-far undetected reactions $\mu^- + P \rightarrow P' + e^-$; $\mu^- + N \rightarrow N' + e^-$. The fraction of high-energy electrons due to these processes to be expected in nuclear emulsions is calculated. L. PINCHERLE

539.172

4340. An interpretation of the meso-disintegration of the deuteron in terms of the strong coupling meson theory. S. MATSUYAMA AND H. MIYAZAWA. Letter in *Progr. theor. Phys.*, **81**, 140–1 (*July*, 1952).

The second-order process: excitation of one of the constituent nucleons to a $j = \frac{3}{2}$ isobar followed by scattering by the nuclear potential to ordinary 2 proton state gives a $3\cos^2\theta + 1$ angular distribution and the observed rapid rise of cross-section with energy. W. J. SWIATECKI

539.172

4341. The interaction of negative μ-mesons with uranium nuclei. W. GALBRAITH AND W. J. WHITEHOUSE. *Phil. Mag.*, **44**, 77–84 (*Jan.*, 1953).

A coincidence experiment is described in which an attempt is made to detect fissions of uranium nuclei resulting from the capture of negative μ-mesons in the cosmic radiation. The result shows that fission is not the most probable process following meson capture, and an upper limit of 0·25 is set for the probability of this fission process occurring. An interpretation of the result is suggested in terms of the competition between fission and neutron emission in the protoactinium isotope Pa^{238} which is formed in the capture process. A.

539.172.1

4342. Helium 3 reactions in nuclear photographic emulsions. J. H. FREMLIN. *Phil. Mag.*, **44**, 141–60 (*Feb.*, 1953).

An attempt has been made to learn something of the kinds of nuclear reaction undergone by He^3 in the range of energy from 0 to 29 MeV, by examining individual reactions taking place in nuclear emulsions. About 130 000 tracks produced by 30 MeV He^3 ions accelerated by the Birmingham University cyclotron were examined. Apart from deflections due to collisions with Ag and Br nuclei, 231 nuclear reactions were observed. Half of these represented close elastic collisions with light nuclei, including 102 with H nuclei. Among the others, reactions of the types (He^3, n), (He^3, α), (He^3, d), (He^3, t), $(He^3, 2p)$, (He^3, pn) and $(He^3, \alpha p)$ were definitely identified, while $(He^3, 2p2\alpha)$ and $(He^3, \alpha pn)$ were almost certainly so. A.

539.172.1

4343. Nuclear reactions with 21-MeV He^3 in a cyclotron. D. N. KUNDU, T. W. DONAVEN, M. L. POOL AND J. K. LONG. *Phys. Rev.*, **89**, 1200–2 (*March* 15, 1953).

He^3 ions were accelerated to a maximum energy of 21 MeV. Bombardment of Be, C, O and Ni led to numerous known activities. The relative cross-sections of the He^3 reactions involving O and Ni nuclei are evaluated. The half-lives of C^{11} and Zn^{62} were found to be $20{\cdot}74 \pm 0{\cdot}10$ min and $8{\cdot}4 \pm 0{\cdot}2$ hr respectively.

539.172.11/.13

4344. Cross sections for the formation of the compound nucleus by charged particles. M. M. SHAPIRO. *Phys. Rev.*, **90**, 171–82 (*April* 15, 1953).

Schematic theory is employed to calculate σ_c, the cross-section for the formation of the compound nucleus when the incident particle is a proton, deuteron, or α-particle. The results are compared with the measured (p, n), $(\alpha; n, 2n, \ldots)$ cross-sections. These should agree in the medium energy region where there is little competition to neutron emission. The curves for the theoretical cross-sections as a function of energy have the same shape as the experimental curves. In many cases the magnitude of the measured cross-sections of different isotopes of the same element differ from one another, and hence from schematic theory results, by about a factor of two. Tables based on accurate values of the Coulomb wave functions are given for computing the cross-section for formation of the compound nucleus by bombardment with protons and deuterons when the atomic number of the target nucleus exceeds 10, and with α-particles when the atomic number of the target nucleus lies between 10 and 30. The tables are applicable over a wide range of nuclear radii. A.

539.172.11

4345. Q values for the $N^{14}(\alpha, p)O^{17}$ reaction. E. HJALMAR AND H. SLÄTIS. Letter in *Phys. Rev.*, **89**, 1151 (*March* 1, 1953).

Nuclear emulsions and Po α's were used as in earlier experiments [Abstr. 5302 (1952)]. Results were: $-1{\cdot}16$ and $-2{\cdot}02$ MeV. F. R. HOLT

539.172.11

4346. Gamma-ray resonances in the alpha-particle bombardment of beryllium and boron. F. L. TALBOTT AND N. P. HEYDENBURG. *Phys. Rev.*, **90**, 186–7 (*April* 15, 1953).

Be^9 and Be^{10} have been bombarded with α-particles from the electrostatic generator at energies up to 3·0 MeV and the γ-radiation yield observed with scintillation counters. The data indicate energy levels in C^{13} at 11·95 and 12·46 MeV and in N^{14} at 12·77, 12·87, 12·90, 13·01 and 13·24 MeV. A number of higher energy levels were indicated in N^{14} but were not satisfactorily resolved. A.

539.172.13

4347. Detonation of proton gas. M. P. MURGAI. *Indian J. Phys.*, **26**, 313–16 (*June*, 1952).

The hydrodynamic theory of detonation has been applied to proton gas. Due to the very high value of the energy released in the proton-proton reaction, the calculated values of detonation parameters are much greater than those for chemical explosives. Due account of radiation pressure and energy has been taken. A.

539.172.13

4348. The cross section for star production in nuclear emulsions by 130 MeV protons. C. F. LEES, G. C. MORRISON, H. MUIRHEAD AND W. G. V. ROSSER. *Phil. Mag.*, **44**, 304–12 (*March*, 1953).

Methods are described whereby stars produced in

nuclear emulsions by protons, in the energy range 110 to 146 MeV may be separated into disintegrations produced in the light (C, N and O), and heavy (Ag and Br) components of the emulsion. The cross-sections obtained for nuclear disintegrations are compared with those predicted by the "transparent nucleus" theory of Fernbach, Serber and Taylor (1949). A.

539.172.13

4349. The absolute determination of resonant energies for the radiative capture of protons by boron, carbon, fluorine, magnesium and aluminium in the energy range below 500 keV. S. E. HUNT AND W. M. JONES. *Phys. Rev.*, **89**, 1283–7 (*March* 15, 1953).

An absolute electrostatic analyser of deflecting angle $\pi/2\sqrt{2}$ radians has been used to measure and stabilize the energy of the proton beam from an air insulated electrostatic generator. The following resonant energies for proton capture by some of the light elements have been measured:

$B^{11}(p, \gamma)C^{12}$	$163{\cdot}8 \pm 0{\cdot}3$ keV.
$C^{12}(p, \gamma)N^{13}$	$456{\cdot}8 \pm 0{\cdot}5$ keV.
$F^{19}(p, \gamma)N^{20*}$	$244{\cdot}4 \pm 0{\cdot}4$ keV.
$Mg^{26}(p, \gamma)Al^{27}$	$314{\cdot}8 \pm 0{\cdot}5$, $338{\cdot}5 \pm 0{\cdot}5$, $389{\cdot}4 \pm 0{\cdot}5$, $436{\cdot}5 \pm 0{\cdot}4$, $454{\cdot}2 \pm 0{\cdot}3$, $484{\cdot}0 \pm 1{\cdot}0$ keV.
$Mg^{24}(p, \gamma)Al^{25*}$	$418{\cdot}0 \pm 0{\cdot}5$ keV.
$Al^{27}(p, \gamma)Si^{28}$	$226{\cdot}3 \pm 1{\cdot}5$, $294{\cdot}1 \pm 0{\cdot}5$, $325{\cdot}6 \pm 0{\cdot}4$, $404{\cdot}7 \pm 0{\cdot}4$, $438{\cdot}5 \pm 0{\cdot}5$, $504{\cdot}0 \pm 0{\cdot}6$ keV.

The high-energy resolution of one thousand obtained has made accurate determination of the half-widths of these resonances possible. A.

539.172.13 : 539.164

4350. Alpha particles from $^{10}B + D$. P. B. TREACY. *Phil. Mag.*, **44**, 325–8 (*March*, 1953).

Thin targets containing separated B^{10} have been bombarded by deuterons of energies 0·59, 0·78 and 1·07 MeV, and the emitted α-particles observed using a differential ionization chamber. Transitions proceeding via the ground state and first excited state of Be^8 have been identified. On the basis of the dispersion theory of Wigner and Eisenbud, the shape of the α-particle spectrum is used to indicate properties of the first excited state of Be^8. A.

539.172.13

4351. Neutrons emitted in the disintegration of beryllium by deuterons. A. J. DYER AND J. R. BIRD. *Austral. J. Phys.*, **6**, 45–52 (*March*, 1953).

Neutrons obtained by bombarding a thick Be target with 600 keV deuterons were studied by the photographic plate technique at angles of emission of 0, 90 and 150°. Five previously reported [Abstr. 4717 (1951)] neutron groups were confirmed, giving energy levels of B^{10} at 0·73, 1·75, 2·20 and 3·64 MeV. An additional group corresponding to an energy level of 2·85 MeV was observed and the evidence for regarding these as genuine Be neutrons is discussed. The Q-value for the ground state transition is found to be $4{\cdot}35 \pm 0{\cdot}02$ MeV which agrees with the value $4{\cdot}36 \pm 0{\cdot}04$ deduced from the most recent masses. A.

539.172.13

4352. The D–H^3 and D–He^3 reactions below 45 keV. R. G. JARVIS AND D. ROAF. Letter in *Proc. Phys. Soc.* [*London*] *A*, **66**, 310 (*March*, 1953).

Using gas targets and photographic emulsions the angular distribution of the α's from D–H^3 was found to be isotropic. The cross-sections in barns were in the range 0·0733 to 0·868 for D–H^3 and $1{\cdot}76 \times 10^{-5}$ to $2{\cdot}3 \times 10^{-4}$ for D–He^3 with bombarding energies from 19 to 44 keV. W. J. SWIATECKI

539.172.13

4353. A study of the reaction $^{11}B(d, n)^{12}C$ by an improved photographic method. W. M. GIBSON. *Phil. Mag.*, **44**, 297–303 (*March*, 1953).

A way of simplifying the microscope measurements and the resulting calculations, in the photographic emulsion method of studying neutron spectra, is described. The energy distribution of neutrons from the reaction $B^{10}(d, n)C^{11}$ has been measured, to show that the saving in time is accompanied by no appreciable loss of accuracy. The method has been used in a study of the angular distribution of neutrons from the reaction $B^{11}(d, n)C^{12}$ at 8·1 MeV. The results are consistent with the theory of the stripping process and confirms that the 4·47 MeV level in C^{12}, like the ground state, has even parity. A.

539.172.13

4354. The angular distribution of $Be^9(d, t)Be^8$ at low energy. P. CÜER AND J. J. JUNG. Letter in *Phys. Rev.*, **89**, 1151–2 (*March* 1, 1953).

The experimental methods are described with some detail. This and other angular distributions are given as curves for a deuteron energy of 1·3 MeV. The magnetically analysed disintegration spectrum observed at 90° is also given. F. R. HOLT

539.172.13

4355. Angular distribution of the reaction $He^3(d, p)He^4$ between 240 keV and 3·56 MeV. J. L. YARNELL, R. H. LOVBERG AND W. R. STRATTON. *Phys. Rev.*, **90**, 292–7 (*April* 15, 1953).

Monoergic deuterons from the Minnesota electrostatic generator were used to bombard a thin gaseous target of He^3. Protons formed in the reaction $He^3(d, p)He^4$ were detected outside the reaction chamber by a NaI scintillation counter. The cross-section for the reaction $He^3(d, p)He^4$ was measured between the angles of 15° and 130° in the laboratory at deuteron energies of 0·260, 0·455, 0·978, 1·51, 2·01, 2·50, 3·01 and 3·56 MeV. The cross-section was measured at a fixed angle of 86° for deuteron energies from 240 keV to 914 keV. A maximum occurred at a deuteron energy of 430 ± 30 keV. The cross-section appears to be isotropic in the centre-of-mass system in the neighbourhood of the maximum. The value of the total cross-section at the maximum is $0{\cdot}90 \pm 0{\cdot}10$ barn. Comparison of this value with the upper bound provided by the single level dispersion formula indicates that the spin of the compound state of Li^5 formed in the reaction is $\frac{3}{2}$. At 978 keV there is a slight angular dependence of the cross-section, which becomes more pronounced at higher energies. At 2·50 MeV the cross-section displays a minimum at approximately 113°. At 3·01 MeV the minimum has shifted to 108°, and at 3·56 MeV it appears at 103°. A.

539.172.3

4356. Excitation functions for the (γ, p) and (γ, T) reactions in lithium-7 for energies up to 24 MeV. E. W. Titterton and T. A. Brinkley. Letter in *Proc. Phys. Soc.* [*London*] *A*, **66**, 194–5 (*Feb.*, 1953).

Measurements with lithium-loaded nuclear emulsions indicate peaks in the excitation functions at the following energies: (γ, p), 15·5 MeV; (γ, T), 9·7 MeV and possibly at 16·7, 21·5 and 23·5 MeV.

J. J. WILKINS

539.172.3

4357. Uranium photofission yields. R. A. Schmitt and N. Sugarman. Letter in *Phys. Rev.*, **89**, 1155–6 (*March* 1, 1953).

Radiochemical studies of uranium photofission products produced by 22, 48 and 100 MeV X-rays are reported. The yield-mass curves deduced have peak-to-trough ratios of 20, 10 and 7 respectively.

J. J. WILKINS

539.172.3

4358. Resolution of the "photon difference method." J. Goldemberg and L. Katz. Letter in *Phys. Rev.*, **89**, 1300–1 (*March* 15, 1953).

This is demonstrated by comparing neutron yield curves obtained for known mixtures of Pb and Cu with the yield curves of the separate elements. J. J. WILKINS

539.172.3

4359. The photodisintegration of the deuteron. L. Hulthén and B. C. H. Nagel. *Phys. Rev.*, **90**, 62–70 (*April* 1, 1953).

The photomagnetic and photoelectric cross-sections have been calculated for γ-energies from threshold (2·23 MeV) up to 20 MeV, using a central Yukawa potential with the same range (i.e. meson mass) in the ^1S and ^3S states and no interaction in the ^3P state. Exchange and quadrupole effects have been neglected. Results are given for 3 ranges, equivalent to meson masses 199, 256 and 298·5, and are compared with recent measurements. In the last section a comparison is made with the results obtained by the effective range method. A.

539.172.3

4360. High energy gamma-gamma cross section of In^{115}. J. Goldemberg and L. Katz. *Phys. Rev.*, **90**, 308–14 (*April* 15, 1953).

Several photonuclear reactions induced in In by the X-rays from a 25-MeV betatron have been measured. Special attention has been given to the reaction $In^{115}(\gamma, \gamma')In^{115*}$. Applying proper corrections, it was found that this reaction has a shape similar to the shape found in the usual photonuclear reactions. This experiment shows that 1 in 7 de-excitations of an excited In nucleus decays by γ-emission. The (γ, n) reaction in In^{115} has been measured and was found to have 0·42 MeV-barn for the integrated cross-section, in good agreement with theoretical predictions. The ratio of the cross-sections for production of the isomeric and ground states of In^{114} has also been studied. It was found that transitions to the isomeric state of In^{114} are highly favoured, as would be expected from an analysis of the spin changes involved. The cross-section for the reaction $In^{115}(\gamma, 2n)In^{113*}$ has been measured and the ratio of this cross-section to the (γ, n) reaction is compared with that predicted by statistical theory. A.

539.172.3 : 612.014.462.481

Energy absorption in human tissue by nuclear processes with high energy X-rays. *See Abstr.* 4324

539.172.4

4361. Neutron total cross sections between 30 and 153 MeV. A. E. Taylor and E. Wood. *Phil. Mag.*, **44**, 95–101 (*Jan.*, 1953).

The neutron total cross-sections of C, Al, Cu, Cd and Pb have been determined as a function of energy in the range 30 to 139 MeV. The Pb total cross-section shows a dip at about 60 MeV and corresponding dips in the Cd and Cu cross-sections appear to occur between 30 and 40 MeV. The neutron total cross-section of H has been measured as $56·9 \pm 1·8 \times 10^{-27}$ cm^2 at a neuton energy of 126 ± 2 MeV. A.

539.172.4

4362. Inelastic neutron scattering in iron. B. Rose and J. M. Freeman. Letter in *Proc. Phys. Soc.* [*London*] *A*, **66**, 120–1 (*Jan.* 1, 1953).

Neutrons from the $T(p, n)He^3$ reaction fell on an Fe ring surrounding a naphthalene–anthracene γ-ray crystal detector. Part of the spectrum of the pulses showed a dependence on the n energy with a threshold of 0·81 MeV, which suggests that they are due to the excitation of the known 1st excited state in Fe^{56} at 0·83 MeV. W. J. SWIATECKI

539.172.4

4363. Inelastic scattering of neutrons by Cd^{111}. A. E. Francis, J. J. G. McCue and C. Goodman. *Phys. Rev.*, **89**, 1232–6 (*March* 15, 1953).

Neutrons with an energy spread of ± 40 keV bombarded a disk of natural Cd; among the products of bombardment was metastable Cd^{111m} produced by inelastic scattering. The yield of Cd^{111m} was measured from its threshold at 396 keV up to 1300 keV. Abrupt changes in the slope of the yield curve are interpreted as showing the onset of (n, n') excitation of higher levels. Such levels occur at 720 and 1150 keV. Below 720 keV, the Cd^{111m} was excited only by direct transition from the ground state. The cross-section for this (n, n') event, which involves known changes of energy, spin and parity was measured at 720 keV. The cross-section is about 10 millibarns. A.

539.172.4

4364. The differential and total neutron scattering cross sections of the deuteron in the energy range 0·1 to 1·0 MeV. P. R. Tunnicliffe. *Phys. Rev.*, **89**, 1247–51 (*March* 15, 1953).

The angular distribution of neutrons scattered by deuterons has been investigated by proportional counter techniques in the energy range 0·1 to 1·0 MeV. The distribution shows a very marked anisotropy at the higher energies which is still appreciable at 135 keV. Values for the total scattering cross-sections are in agreement with earlier data down to 446 keV but apparently increase above the accepted value for the unbound thermal cross-section. A.

539.172.4

4365. Gamma-radiation from interaction of 14-MeV neutrons with iron. V. E. SCHERRER, R. THEUS AND W. R. FAUST. *Phys. Rev.*, **89**, 1268–70 (*March* 15, 1953).

Experiments have been performed to observe γ-rays produced by the interaction of 14-MeV neutrons with Fe. Although the γ-spectrum appears to be continuous below 3·0 MeV, there may be discrete γ-rays at 3·3, 4·4, 5·8, 7·1 and 8·75 MeV. The total cross-section for γ-ray production is $4{\cdot}6 \pm 0{\cdot}5$ barn. A.

539.172.4

4366. Total fast neutron cross sections of Co, Ga, Se, Cd, Te, Pt, Au, Hg, and Th. M. WALT, R. L. BECKER, A. OKAZAKI AND R. E. FIELDS. *Phys. Rev.*, **89**, 1271–2 (*March* 5, 1953).

The total neutron cross-sections of Co, Ga, Se, Cd, Te, Pt, Au, Hg and Th were measured as a function of neutron energy from 0·1 to 3 MeV. An estimate of the error caused by neutrons scattered into the detector was made by measuring the apparent cross-section as a function of sample diameter. The results give additional evidence that, neglecting resonance structure, total neutron cross-section curves have characteristic shapes which change slowly with atomic weight. A.

539.172.4

4367. The thermal neutron capture cross sections of Pa^{231} and Pa^{232}. R. ELSON, P. A. SELLERS AND E. R. JOHN. *Phys. Rev.*, **90**, 102–3 (*April* 1, 1953).

The neutron capture cross-section of Pa^{231} has been determined to be 293 barns, the largest uncertainty in this determination being due to the uncertainty in the half-life of U^{232} and being of the order of 15%. The neutron capture cross-section of Pa^{232} was determined to be about $40\binom{+40}{-20}$ barns. A.

539.172.4

4368. Cross sections for products of 90-MeV neutrons on carbon. D. A. KELLOGG. *Phys. Rev.*, **90**, 224–32 (*April* 15, 1953).

Determinations have been made of the cross-sections for the products of 90-MeV neutrons on C in the case of practically all reactions that occur. Beta-counting of the activities generated in a rotating polyethylene disk yielded cross-sections for the production of some heavy fragments, identified as to isotope and atomic number. Cloud-chamber study yielded cross-sections for almost all reactions, but resulted in the identification of most of the heavy fragments only by atomic number. The rotating disk method cross-sections were normalized to the $C^{12}(n; 2n)C^{11}$ cross-section, and the cloud-chamber method cross-sections were normalized to the n–p cross-section. A.

539.172.4

4369. A bibliography on fission. *Atomic Energy Res. Establ.* [*Harwell*] *Rep. Inf./Bib.* 76, 32 *pp.* (*Dec.*, 1951).

539.172.4

4370. Short-lived cerium isotopes from uranium fission. A. A. CARETTO, JR AND S. KATCOFF. *Phys. Rev.*, **89**, 1267–8 (*March* 15, 1953).

It was demonstrated that the previously reported 1·8 hr Ce^{145} and 4·5 hr Pr^{145} do not occur among the U fission products. Ce^{146} and Pr^{146} were briefly re-investigated: the former decays with a half-life of $13{\cdot}9 \pm 0{\cdot}6$ min and emits β-rays of 0·9 MeV maximum energy followed by soft γ-rays; the latter decays with a half-life of $24{\cdot}4 \pm 0{\cdot}5$ min and its maximum β-ray energy is 3·8 MeV. In addition, it was shown that any undiscovered short-lived Ce fission products must decay with half-lives shorter than 6 min. A.

539.172.4

4371. Fission neutron spectrum of U^{235}. D. B. NICODEMUS AND H. H. STAUB. *Phys. Rev.*, **89**, 1288–90 (*March* 15, 1953).

A high pressure ionization chamber has been used to measure the energy distribution of proton recoils from the neutrons which are emitted during the thermal neutron fission of U^{235}. The energy spectrum of the fission neutrons is obtained by applying suitable wall corrections and by using 2·5-MeV d–d neutrons for an energy calibration. Measurements were made in the range from 1 to 4 MeV, and within the experimental errors, the resulting fission spectrum follows Watt's [Abstr. 8469 (1952)] semi-empirical relation, $N(E) = e^{-E} \sinh\sqrt{(2E)}$. A.

539.172.4

4372. The reactor as a neutron source. D. J. HUGHES. *Nucleonics*, **11**, 30–5 (*Jan.*, 1953).

The energy distribution of the flux and density of neutrons in the core, reflector and thermal column, and in beams from a thermal reactor are discussed.

L. R. SHEPHERD

539.172.4

4373. Design of a control system for a low-cost research reactor. T. E. COLE. *Nucleonics*, **11**, 32–7 (*Feb.*, 1953).

The control system for the "ORNL swimming-pool" reactor [Abstr. 2730 (1953)] is described. A total excess reactivity of 1·3% has to be provided to cover the effects of temperature coefficient, Xe poisoning, fuel depletion and operational requirements, with a further 2% to cover losses introduced by experimental equipment. Safety rods, containing B, capable of reducing the reactivity by 5%, are held out by electromagnets and are released in less than 0·04 seconds if the reactor power exceeds the shut-down level. A control rod, controlling 0·5% of reactivity can be operated, either manually or in an automatic system. B-coated γ-compensated ionization chambers are used to monitor the power level of the reactor. Both linear and logarithmic power level indications are provided with these chambers, the logarithmic amplifier utilizing the proportionality of the voltage across a thermionic diode, to the logarithm of the current. The output of this amplifier is differentiated in an RC circuit to give an indication of the reactor time period. A fission chamber is employed, to monitor the power at low level, when starting up with a high γ-radiation background. In this case a pulse counting technique is used, the fission pulses being filtered by a discriminator.

L. R. SHEPHERD

539.172.4

4374. Uranium-graphite lattices. E. A. GUGGENHEIM AND M. H. L. PRYCE. *Nucleonics*, **11**, 50–60 (*Feb.*, 1953).

Expressions are derived for: the fast fission factor,

thermal utilization factor, resonance escape probability, reproduction constant, slowing down and diffusion lengths, and Laplacian in graphite-uranium lattices with Al sheathed elements. Appropriate numerical values are introduced into the formulae, which are then applied in the calculation of critical sizes of right cylindrical piles with graphite reflectors and U rods arranged in parallel channels in square or hexagonal lattices. The calculations are made for various; radii of U rods; width of air gaps surrounding the rods, and radii of lattice cell. A constant Al sheath thickness (1·15 mm) is assumed. Results are graphed and tabulated. L. R. SHEPHERD

[This article is essentially the same as *A quantitative study of uranium–graphite lattices*, E. A. Guggenheim and M. H. L. Pryce. *Atomic Energy Res. Establ.* [*Harwell*] *Rep.* R/R922, 42 *pp.* (*June*, 1952)].

539.172.4 : 536.24

4375. The effect of turbulence on heat transfer in a pile with a liquid reactant. E. N. PARKER. *J. appl. Phys.*, **24**, 451–2 (*April*, 1953).

The spacing of cooling surfaces in a liquid reactant pile is considered in an elementary fashion. The resulting physical picture is that the eddy diffusion of thermal energy, which is enhanced by large free volumes of fluid, does not increase as fast as linearly with the spacing of cooling surfaces. Thus, for a given temperature difference between reactant and coolant, the total heat transfer decreases with increased spacing of the cooling surfaces. This disadvantage of large spacings is to be set off against the advantage of decreased parasitic neutron losses to the coolant. A.

539.172.4 : 621–52 : 621.039.42

4376. Automatic control characteristics of thermal neutron reactors. J. H. BOWEN. *Proc. Instn Elect. Engrs, I*, **100**, 102–109, 116–20 (*May*, 1953).

For abstract see Abstr. 1925 (1953).

539.172.4 : 621.039.42 : 621–5

4377. The control of a thermal neutron reactor. R. V. MOORE. *Proc. Instn Elect. Engrs, I*, **100**, 90–101, 116–20 (*May*, 1953).

For abstract see Abstr. 1926 (1953).

ATOM AND MOLECULE BEAMS . MESONS NEUTRONS 539.18

539.18

4378. On isobaric states of nucleons and the scattering of π-mesons by protons. B. FERRETTI. Letter in *Nuovo Cimento*, **9**, 312–13 (*March*, 1952) *In Italian.*

It is pointed out that the existence of "excited nucleons" would make the scattering cross-section by protons different for positive and negative π-mesons through the non-vanishing matrix elements between the system proton-π^- and simply a neutron. L. PINCHERLE

539.18

4379. On the model of *V*-particle and meson–nucleon scattering. K. SAWADA. Letter in *Progr. theor. Phys.*, **7**, 592–5 (*May–June*, 1952).

The assumption that *V*-meson production takes place in 2 steps through a strongly interacting V' particle of mass ~2800 m_e affects the scattering of π's on nuclei. The cross-sections for $\pi^{\pm} + P \rightarrow \pi^{\pm} + P$, $\pi^- + P \rightarrow \pi^0 + N$, are worked out as functions of energy and compared with experiments of P. I. Isaacs *et al.* (1952) and Fermi *et al.* (1952). W. J. SWIATECKI

539.18

4380. The production of τ-mesons in ice. A. J. HERZ, P. E. HODGSON AND R. M. TENNENT. *Phil. Mag.*, **44**, 85–91 (*Jan.*, 1953).

Nuclear-research emulsion has been exposed to the cosmic radiation under various thicknesses of ice. Three events interpreted as the decay of τ-mesons have been observed, and measurements on their tracks show that these particles decay into three π-mesons of total kinetic energy (73 ± 6) MeV and have mass $(965 \pm 12)m_e$. They are found with a frequency of about 0·0008 τ-mesons per star in emulsion exposed under ice. The emulsion was examined for nuclear disintegrations produced by heavy mesons, and for τ-mesons decaying in flight, but no such events were found. The lifetime is shown to be longer than 10^{-9} sec. A.

539.18

4381. Range distribution of μ-mesons from π-meson decay in photographic emulsion. W. F. FRY AND G. R. WHITE. *Phys. Rev.*, **90**, 701–10 (*April* 15, 1953).

The lengths of μ-meson tracks from 1000 π-meson decays have been measured in two Ilford C-2200-micron thick emulsions, which had been exposed by R. Sagane in a spiral orbit spectrometer to the Berkeley cyclotron. Shrinkage factors obtained from this analysis were used to calculate the true ranges of the μ-meson tracks. The distribution of true ranges meets statistical tests for a Gaussian distribution; it has a mean of 597 ± 1 microns and a standard deviation of 29·1 ± 0·7 microns. Since decay in flight and soft photon emission accompanying decay have negligible effects in this study, the straggling parameter for 4·1 MeV μ-mesons in photographic emulsion can be obtained; it is 4·86 ± 0·12%. The effect of experimental uncertainties on these values can be about 0·1%, which is slightly less than the statistical limits imposed by the finite number of events. A.

539.18

4382. On the lifetime of the μ^+- and μ^--mesons. N. DALLAPORTA. Letter in *Nuovo Cimento*, **9**, 449–52 (*May*, 1952) *In Italian.*

It is shown that a critical examination of experimental data suggests that the lifetime of the negative μ-meson may be longer than that of the positive one. Should this be confirmed, it would be an effect of the binding of the negative particle in a Bohr orbit.

L. PINCHERLE

539.18

4383. An empirical mass spectrum of elementary particles. Y. NAMBU. Letter in *Progr. theor. Phys.*, **7**, 595–6 (*May–June*, 1952).

The empirical masses of μ, π, V_2, τ, κ, V_1 mesons can be fitted by $\frac{1}{2}(n+1)\times 137\, m_e$, where n is an integer. The Q values in V_1 decay are also multiples of $\frac{1}{2}\times 137\, m_e$. W. J. SWIATECKI

539.18

4384. The mean life of charged *V*-particles. J. P. Astbury, J. S. Buchanan, P. Chippindale, D. D. Millar, J. A. Newth, D. I. Page, A. Rytz and A. B. Sahiar. *Phil. Mag.*, **44**, 242–8 (*March*, 1953).

Eight hundred tracks of slow particles have been photographed during a cloud chamber experiment on penetrating showers. Measurements of tracks produced by ten heavy, negative, non-decaying particles are presented. The total observed time of flight of these particles is $1{\cdot}6\times10^{-8}$ sec. After combining this time with the number of slow *V*-particles observed to decay in the cloud chamber, it is concluded that at least one type of heavy meson must have a mean life greater than 4×10^{-9} sec. A.

539.18

4385. On the statistical estimation of mean lifetimes. M. S. Bartlett. *Phil. Mag.*, **44**, 249–62 (*March*, 1953).

Statistical methods of estimation of the mean lifetimes of unstable particles from cloud chamber photographs are discussed (i) for decaying particles only, (ii) when non-decaying particles can be recognized. Some discussion is also given of the effect of momentum errors, and of estimation and discrimination problems for mixtures of particles. A.

539.18

4386. Photo-electric determination of the mass of the Bristol $\varkappa_1$-meson. K. Kristiansson. *Phil. Mag.*, **44**, 268–80 (*March*, 1953).

The track-density of the Bristol κ_1-meson has been determined photoelectrically. The measurements have been accurately corrected for uneven development and transparency of the emulsion. The mass has been calculated by comparison with tracks which have roughly the same slope as the meson-track and also by comparison with a proton track which crosses that of the meson. The result of the mass-determination is $m\kappa_1 = 1518 \pm 70$ electron masses. A.

539.18

4387. Study of elastic pion-hydrogen scattering in photographic emulsions. G. Goldhaber. *Phys. Rev.*, **89**, 1187–9 (*March* 15, 1953).

Pion-hydrogen elastic scattering events were observed in photographic emulsions exposed to the 75 ± 5 MeV negative and positive pion beams of the Nevis synchrocyclotron. The methods of identification, based on the energy momentum conservation in the interaction, are described. The cross-section measured for the elastic scattering of negative and positive pions from hydrogen at 75 ± 5 MeV are $\sim$3 mb and 41 ± 15 mb, respectively. A.

539.18

4388. Interactions of μ-mesons. W. D. Walker. *Phys. Rev.*, **90**, 234–8 (*April* 15, 1953).

The energy spectrum of electrons knocked on by μ-mesons has been measured over a wide range of energies. It is found that the theoretical cross-section as derived by Bhabha fits the data for knock-on energies of a few MeV up to energies of the order of a BeV. From these data it is concluded that any particle structure that might exist does not appreciably affect collisions with impact parameters of 6×10^{-13} cm or more. It is found that the theoretical cross-section for direct pair production by μ-mesons is of the right order of magnitude. From the experiment an upper limit of 2×10^{-29} cm^2 nucleon is set for the cross-section for the production by μ-mesons of a penetrating secondary of the type originally reported by Braddick and Hensby. A.

539.18

4389. A search for V^0 particles produced by 450-MeV protons. R. L. Garwin. *Phys. Rev.*, **90**, 274–8 (*April* 15, 1953).

A search was made for high-energy γ-rays originating in vacuum close to a target bombarded by 450-MeV protons. The absence of a significant number of such γ's indicates that the cross-section per nucleon is less than 7×10^{-33} cm^2 for production of unstable particles which decay into π^0 with a lifetime $\sim2\times10^{-10}$ sec. A.

539.181

4390. Charge states of a helium beam in hydrogen, helium, air, and argon. E. Snitzer. *Phys. Rev.*, **89**, 1237–44 (*March* 15, 1953).

Measurements have been made of the fractions of a He beam in the He^0, He^+, and He^{++} charge states in the energy range of 100 keV to 480 keV for beams in H, He, air and A. For the four gases, the He^0 and He^+ components are equal for He energies of 148 keV, 145 keV, 98 keV and 115 keV, respectively. The ratios of the electron loss to electron capture cross-sections between He^+ and He^{++} fitted a simple power dependence of $(\sigma_l/\sigma_c) \propto V^m$, where V is the velocity of the He in the beam and m equals 6·1, 5·1, 5·2 and 6·3, respectively, for the four gases studied. For electron capture and electron loss between He^0 and He^+ the exponent m varies from 2·6, 2·0, 2·8 and 3·4 at 100 keV to 4·0, 4·0, 4·3 and 5·1 at 450 keV. A.

539.185

4391. Spin-orbit coupling and neutron polarization. M. Verde. Letter in *Nuovo Cimento*, **9**, 376–9 (*April*, 1952) *In Italian.*

It is shown that, to gain information on the polarization vector, it is advisable to study experimentally the angular dependence, about the direction of incidence of the neutrons, of the neutron scattering cross-section on nuclei of zero spin. L. PINCHERLE

539.185

4392. Scattering of neutrons by deuterons. R. K. Adair, A. Okazaki and M. Walt. *Phys. Rev.*, **89**, 1165–70 (*March* 15, 1953).

Angular distributions and total cross-sections for neutrons scattered by deuterons were measured at various neutron energies ranging from 220 keV to 3 MeV. A proportional counter filled with D was irradiated with monoenergetic fast neutrons produced by bombarding thin Li and T-filled Zr targets with protons from the electrostatic generator. Angular distributions of the neutrons scattered by deuterons were determined by measuring the distribution in energy of the recoiling deuterons with a differential discriminator. Total neutron–deuteron cross-sections were measured by comparing the neutron transmission of heavy water with ordinary water.

Phase shifts determined from an analysis of the data were not in agreement with theoretical conclusions of Buckingham and Massey or of Verde. A.

539.185

4393. A new rigorous lower bound on the range of the triplet neutron-proton interaction. L. L. FOLDY. *Phys. Rev.*, **89**, 1251–4 (*March* 15, 1953).

The experimental values of the electric quadrupole moment and percentage *D* state in the deuteron together with the effective triplet range of the neutron-proton interaction are employed to determine a rigorous lower bound on the "cut-off" range of the neutron-proton interaction. The latter is defined to be the range beyond which the deuteron wave functions have effectively their asymptotic form. A.

539.185

4394. Thermal energy relaxation length of Ra–Be neutrons in water. J. TITTMAN. *Phys. Rev.*, **90**, 256–7 (*April* 15, 1953).

Measurement of the density of thermal neutrons about a point Ra–Be source in infinite water medium has been extended to one metre. The thermal relaxation length is found to be constant at $9{\cdot}58 \pm 0{\cdot}2$ cm over a range in which neutron density changes by 10^5. A.

539.185 : 538.222

4395. The dependence of paramagnetic neutron scattering on coupling between Mn^{++} ions. P. J. BENDT. *Univ. Microfilms Publ. No.* 2795 (1951) 132 *pp.* (Photo-reproduction.)

Abstract in *Microfilm Abstracts*, **11**, *No.* 4, 1080–2 (1951).

539.185.08

4396. Two liquid scintillation neutron detectors. C. O. MUEHLHAUSE AND G. E. THOMAS, JR. *Nucleonics*, **11**, 44–8 (*Jan.*, 1953).

The use of boron esters (particularly methyl borate) in solution with terphenyl and diphenylhexatriene in phenylcyclohexane, as neutron scintillation detectors, is discussed. Detection efficiencies approaching 100%, both for thermal and epithermal pile neutrons, has been obtained with cells containing 2 or 3 in^3. of liquid. The pulses due to the $B^{10}(n, \alpha)$ reactions are much smaller than those due to secondary electrons produced by γ-rays and discrimination is obtained by selecting only those pulses lying below a certain discriminator-bias level. Cooling, or the use of two photomultipliers in coincidence, is required, in order to reduce background noise. A fast-neutron detector, which depends on the observation of double pulses, is described. The first pulse is due to the recoil protons produced as the neutron slows down and the second follows about a half-microsecond later when the neutron is captured in B^{10} with the emission of an α-particle. LT.-C. SHEPHERD

539.185.08

4397. A fast and efficient neutron detector. J. KIRKBRIDE. Letter in *Nature* [*London*] **171**, 564 (*March* 28, 1953).

Solutions of borazole ($B_3N_3H_6$) in *p*-xylene containing 5 g *p*-terphenyl per litre gives an efficient neutron detector with up to 400 times the density of a BF_3 gaseous counter and 1/100 of the time response of the latter. G. F. J. GARLICK

539.185.08 : 621.039.42

4398. Neutron detectors for reactor instrumentation. T. A. J. JAQUES, H. A. BALLINGER AND F. WADE. *Proc. Instn Elect. Engrs*, *I*, **100**, 110–20 (*May*, 1953). For abstract, see Abstr. 1159 (1953).

STRUCTURE OF SOLIDS 539.2

539.2 : 539.32 : 539.4.016

4399. The measurement of the Young's modulus of metals and alloys by an interferometric method. II. The influence of heat-treatment on the Young's moduli and densities of Ni–Mn alloys. T. FUKUROI AND Y. SHIBUYA. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **2**, 829–36 (*Dec.*, 1950).

An investigation has been performed on the change of the Young's modulus and the density of Ni–Mn alloys, having the composition from 1·43 to 23·8% Mn, when they were subjected to various heat-treatments. The results obtained are as follows. (1) The Young's modulus of the alloys which were worked or quenched decreases steadily with the increase of manganese content, but after the samples were annealed thoroughly for many hours, the Young's modulus *v*, composition curve is not as steady as in the former cases. (2) The Young's modulus of Ni_3Mn in the ordered state is larger by more than 10% than that in the disordered state. (3) the influence of the heat-treatment on the density could not be found beyond the limits of experimental error. A.

539.211

4400. Properties of metallic surfaces. *London: Institute of Metals* (1953) 370 *pp.* [*Monograph and Report Series No.* 13].

The volume contains 13 papers presented at a symposium held in London in November, 1952. Contents: *Specialized microscopical techniques in metallurgy*, S. Tolansky. *Radioisotopes in the study of metal surface reactions in solutions*, M. T. Simnad. *The influence of machining and grinding methods on the mechanical and physical condition of metal surfaces*, P. Spear, I. R. Robinson and K. J. B. Wolfe. *The effect of lubrication and nature of superficial layer after prolonged periods of running*, F. T. Barwell. *The crystalline character of abraded surfaces*, P. Gay and P. B. Hirsch. *The effect of surface conditions on the mechanical properties of metals, mainly single crystals*, E. N. da C. Andrade. *The effect of surface condition on the strength of brittle materials*, C. Gurney. *The influence of surface condition on the fatigue strength of steel*, R. J. Love. *The influence of surface films on the friction and deformation of surfaces*, F. P. Bowden and D. Tabor. *Diffusion coatings*, D. M. Dovey, I. Jenkins and K. C. Randall. *The nature and properties of the anodic film on aluminium and its alloys*, H. W. L. Phillips. *Chemical behaviour as influenced by surface condition*, U. R. Evans. *The effect of method of preparation on the high-frequency surface resistance of metals*, R. G. Chambers and A. B. Pippard.

539.213.1 : 536.7

4401. The irreversible approach to equilibrium in glasses. R. O. DAVIES AND G. O. JONES. *Proc. Roy. Soc. A*, **217**, 26–42 (*March* 24, 1953).

In liquids the molecular configuration is a function of temperature. If in a given substance supercooling of the liquid is possible to such a low temperature—the "transformation temperature" (T_g)—that the viscosity reaches about 10^{13} poises, the required changes in configuration become impossible and at all lower temperatures the structure remains frozen. This causes apparent discontinuities in derivative properties (such as the specific heat) and departures from the Nernst heat theorem. Below T_g the substance is said to be in the glassy state. In the neighbourhood of T_g relaxation towards the appropriate equilibrium structure can be easily observed. An approximate thermodynamic description of the behaviour can be given by introducing an ordering parameter, z, to represent the configuration. The value of z remains fixed for rapid changes in temperature and pressure. This leads to a number of relations between certain properties of the equilibrium liquid and of the glass. One of these (given by Prigogine and Defay, 1950) is $\Delta\kappa\Delta C_p = TV(\Delta\alpha)^2$, where κ, C_p and α are the compressibility, heat capacity and expansivity, and $\Delta\alpha = \alpha_{\text{liquid}} - \alpha_{\text{glass}}$, etc. New results obtained with glucose and analysis of existing data suggest that the relations are obeyed only very approximately and that the one-parameter model is therefore inadequate. Near equilibrium it is convenient to use—instead of z—a "fictive temperature," $\bar{T}$, defined so that with fixed p and z the glass would be in equilibrium at $T = \bar{T}$. A fictive pressure, $\bar{p}$, can be similarly defined. To a first approximation, the approach to equilibrium is described by means of a volume viscosity, η_v, such that (at constant p and T) $(1/V)(dV/dt) = -[(p - \bar{p})/\eta_v]$. The relaxation time for observations of the approach to equilibrium is then given by $\tau = \text{const.}\ \eta_v\Delta\kappa$, where the constant depends on the experimental arrangement. τ has been measured for glycerol and glucose near their transformation temperatures and the results used to find η_v and its dependence on temperature. It was found that: (i) The activation energies of volume viscosity for glycerol (25 kcal/mole) and glucose (130 kcal/mole) are equal to those of the shear viscosity (η). Thus η_v/η is independent of temperature. (ii) η_v/η is of the order 10 for glycerol and is about 200 for glucose. (iii) dV/dt is proportional to $(p - \bar{p})$ for only very small displacements from equilibrium. It follows that the concept of volume viscosity must be used with caution. A.

539.217

4402. Self-diffusion in mono-calcium ferrite. J. A. HEDVALL, C. BRISI AND R. LINDNER. *Ark. Kemi*, **4**, *Paper* 25, 377–80 (1952) *In German.*

The self-diffusion of radioactive Fe and Ca in sintered tablets of $CaO.Fe_2O_3$ was measured. The temperature functions of the diffusion constants are: for Fe, $D = 3{\cdot}2\ \exp(-72\,000/RT)\ \text{cm}^2\ \text{sec}^{-1}$; for Ca, $D = 3\times10^1\ \exp(-86\,000/RT)\ \text{cm}^2\ \text{sec}^{-1}$. A.

539.217

4403. Diffusion of radioactive iron (3) oxide and zinc-iron-spinel. R. LINDNER. *Ark. Kemi*, **4**, *Paper* 26, 381–4 (1952) *In German.*

The measurements were made in sintered tablets. The temperature functions of the diffusion constants are: for Zn–Fe spinel, $D = 8{\cdot}5\times10^2\ \exp(-82000/RT)\ \text{cm}^2\ \text{sec}^{-1}$, for Fe oxide, $D = 4\times10^4\ \exp(-112000/RT)\ \text{cm}^2\ \text{sec}^{-1}$ (probable value). A.

539.217

4404. Diffusion of silicon in ferrite. F. J. BRADSHAW, G. HOYLE AND K. SPEIGHT. Letter in *Nature* [*London*] **171**, 488 (*March* 14, 1953).

Butt welded couples of Fe–Fe/3–4% Si were annealed for various periods at 1435 ± 5°c and from the resulting silicon distributions, determined by spectrographic analysis, the diffusion coefficient was calculated to be $1{\cdot}1\times10^{-7}\ \text{cm}^2/\text{sec}$. A. D. LE CLAIRE

539.217

4405. Auto-diffusion in barium titanate. A. GARCIA-VERDUCH AND R. LINDNER. *Ark. Kemi*, **5**, *Paper* 29, 313–16 (1953) *In German.*

Auto-diffusion of Ba in sintered tablets of $BaO.TiO_2$, as determined with the use of Ba^{131} (half-life 11·7 days) proceeds in accordance with the law $D = 0{\cdot}8\ \exp(-89\,000/RT)\ \text{cm}^2\ \text{sec}^{-1}$. Transference of Ba ions has been detected, the mobility of Ba being increased during and after the exposure of material to electric field and high temperature.

F. LACHMAN

539.217 : 537.531

4406. Effect of X-ray irradiation on the self-diffusion coefficient of Na in NaCl. D. MAPOTHER. *Phys. Rev.*, **89**, 1231–2 (*March* 15, 1953).

The self-diffusion coefficient is decreased if the crystal is exposed to X-rays during the diffusion process. This effect was observed at temperatures under 550°c and was not observed at higher temperatures. A.

539.219 : 548.5

4407. Distribution coefficient of indium in germanium on crystallization. J. J. DOWD AND R. L. ROUSE. Letter in *Proc. Phys. Soc.* [*London*] *B*, **66**, 60–1 (*Jan.*, 1953).

Single crystals of Ge were grown by the method of Teal and Little from a melt containing radioactive In. The crystal was sectioned and the relative activities (proportional to concentration of In) measured with a Geiger counter. The absolute concentration of one section was measured by taking it into solution chemically. The result for k is $(1{\cdot}25 \pm 0{\cdot}15)\times10^{-3}$. C. A. HOGARTH

539.219.1

4408. On the kinetics of the disorder-order transformation in Cu_3Au. N. W. LORD. *J. chem. Phys.*, **21**, 692–9 (*April*, 1953).

The isothermal order-dependent change in the Young's modulus of a single crystal of Cu_3Au is measured as a function of time at various temperatures in the range 279·3°c to 384·3°c. These temperatures were reached by quenching rapidly from an equilibrium state 28·2°c above the critical temperature (386·0°c). The time variations of Young's modulus indicate two distinct stages of the disorder-order transformation. The initial stage starts immediately and is completed a few minutes after quench-

ing, while the later stage requires a few minutes before starting and then proceeds very slowly toward an equilibrium state. "Relative relaxation times" are associated with each of them. In conformance with the work of Sykes and Evans and others, the initial stage is described as the formation of contiguous, antiphase, ordered domains by means of normal atomic interdiffusion. The later stage consists of the coalescence of these domains and requires at least two different geometrically constrained diffusion processes. A.

539.26

4409. Conference on the application of X-rays to the study of materials. V. A. POSPELOV. *Vestnik Akad. Nauk SSSR*, **1952**, *No.* 9, 122–3. *In Russian.*

Administrative report of the 4th All-Union conference held in Leningrad about June, 1952. 51 papers were presented in the fields of X-ray structure analysis, X- and γ-ray defectoscopy, X-ray spectrum analysis and electronography. Industrial applications were stressed. 595 delegates attended.

A. L. MACKAY

539.26

4410. The X-ray diffraction from quartz and the influence of surface treatment. G. BROGREN. *Ark. Fys.*, **6**, *Paper* 31, 321–34 (1953).

Rocking curves were recorded, using a Geiger counter, for the $10\bar{1}0$ and $11\bar{2}0$ faces, before and after etching for various lengths of time in HF solution. These indicate that a deformed surface layer is produced by the initial grinding, which increases the width of the rocking curve, decreases the maximum reflecting power and increases the integrated reflecting power. This is completely removed when a 400 Å layer has been etched off. The experimental widths are greater than theoretical values, while the experimental reflecting powers are less than theoretical.

A. R. STOKES

539.26

4411. Low-angle X-ray diffraction of bone. A. ENGSTRÖM AND J. B. FINEAN. Letter in *Nature* [*London*] **171**, 564 (*March* 28, 1953).

Diffraction photographs of cross-sections and longitudinal sections of bone indicated that the hydroxylapatite crystals are elongated with their long axes parallel to the collagen fibres: their diameter is 60–80 Å and length probably three times this.

A. R. STOKES

539.26 : 532.13

4412. Diffraction of X-rays by aqueous solutions of caramel sugar. A. CARRELLI AND E. TARTAGLIONE. *Nuovo Cimento*, **9**, 440–1 (*May*, 1952) *In Italian.*

Scattering curves are reproduced, showing changes in liquid structure over the range of concentrations for which the product of viscosity and electrical conductivity is not constant. A. R. STOKES

539.27

4413. Determination of size of particles with the electron microscope. E. ATHERTON. Letter in *Nature* [*London*], **171**, 350–1 (*Feb.* 21, 1953).

The method used by Timbrell [Abstr. 7980 (1952)] for size discrimination on optical micrographs, was applied to electron micrographs. R. S. PEASE

539.27

4414. Direct measurement of images in the electron microscope. H. FROULA. *Rev. sci. Instrum.*, **24**, 304–6 (*April*, 1953).

A method and a working model are described for making rapid, moderately accurate measurements of images directly on the fluorescent screen of an electron microscope without the usual intermediate photography. A shadow of variable magnitude is cast over part of the image. By means of an external control, the size of the shadow is adjusted to match the unknown dimension of the image. Calibrations on the control then indicate the magnitude of this dimension.

A.

539.27 : 771.534.5

4415. A step wedge for sensitometry with the electron microscope. J. HAMILTON. *Rev. sci. Instrum.*, **24**, 309–12 (*April*, 1953).

A new method of making intensity-scale electron exposures on a photographic emulsion directly in the electron microscope is described. A microscopic, variable-thickness step wedge for modulating the electron-beam intensity is prepared by a multiple shadowing technique applied to a simple microscopic specimen. An electron exposure through this wedge, in the specimen position of the microscope, gives an enlarged stepped image on the test emulsion which can be read on a conventional densitometer. Comparison exposures are made simultaneously on an emulsion of known characteristics and an unknown test emulsion. Thus, the contrast and the sensitivity of the test emulsion relative to that of the emulsion selected as a standard can be determined quickly and accurately. Also, the characteristics of graininess and sharpness of the test emulsion can readily be evaluated. A.

ELASTICITY . STRENGTH . RHEOLOGY

539.3/.8

539.32

4416. Elastic constants of nickel crystals. M. YAMAMOTO. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **3**, 308–20 (*June*, 1951).

Young's moduli of Ni single crystals were measured by the method of magnetostrictive vibration. Those for the principal crystal directions are $E_{(100)} = 1{\cdot}198$ $E_{(110)} = 2{\cdot}008$, and $E_{(111)} = 2{\cdot}592 \times 10^{12}$ dynes/cm². The three elastic coefficients determined by combining the measured data of the cubic compressibility for polycrystalline Ni are $S_{11} = 0{\cdot}835$, $S_{12} = -0{\cdot}328$ and $S_{44} = 0{\cdot}978 \times 10^{-12}$ cm²/dyne. A.

539.32

4417. Improvement of Cornu's method for determining elastic constants. M. S. SODHA AND Y. P. VARSHNI. Letter in *Curr. Sci.*, **22**, 11 (*Jan.*, 1953).

A method is given for calculating Young's modulus and Poisson's ratio for a transparent beam, from the measurement of interference fringes formed by the surface of the loaded beam and a test plate, in the case when the beam has unknown radii of curvature in the unstressed state. J. G. OLDROYD

539.32 : 534.23 : 532.12

Internal pressure. *See Abstr.* 3898

539.32 : 539.11

4418. A theoretical study of the Young's moduli of binary solid solutions. Y. SHIBUYA. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **3**, 645–54 (*Dec.*, 1951).

Using a theory presented previously [Abstr. 3816 (1951)], the author examines the relation between Young's modulus and composition in binary solid solutions. Denoting the force constants for the interaction-energy between A atoms, that between B atoms and that between atoms A and B, by ξ_{AA}, ξ_{BB} and ξ_{AB} respectively, the following results were obtained. (1) In the case that ξ_{AB} is equal to the mean value of ξ_{AA} and ξ_{BB}, there is a linear relation between Young's modulus and composition. (2) In the case that ξ_{AB} is not equal to the mean value, there is a non-linear relation. (3) The theoretical curves obtained with appropriate values of ratios of the force constants agree well with the experimental ones. (4) Using the value of ξ_{AA} obtained from the measured values of the lattice constant and the compressibility, the magnitude of Young's modulus for molybdenum in polycrystalline form can be estimated, and agrees within about 10% with the measured value. A.

539.373 : 548.0

4419. A theoretical examination of the plastic deformation of crystals by glide. J. F. W. BISHOP. *Phil. Mag.*, **44**, 51–64 (*Jan.*, 1953).

Proofs are given of theorems stated in the Bishop–Hill theory of crystal distortion. Mathematical relations are established for the deformation of crystals by simultaneous shears, and the possibility of enforcing an arbitrary strain by glide is examined. The uniform stress states not exceeding the critical shear stresses in the glide-directions are discussed, and a geometrical picture of stress and strain states is developed. It is proved that it is always physically possible to enforce a given strain by glide provided it is geometrically possible. The uniform elongation of a face-centred cubic crystal is examined. A.

539.4.014.13

4420. Internal stresses caused by disorder in vitreous materials. H. RAWSON. Letter in *Nature* [*London*] **171**, 169 (*Jan.* 24, 1953).

The disordered structure of a glass implies the presence of local stresses similar to those set up by an edge dislocation. These stresses may approach the theoretical breaking strength and thus the "external" stresses required to induce fracture may be much reduced. Some experimental support for this idea is cited. R. O. DAVIES

539.4.014.13

4421. Stress waves in solids. H. KOLSKY. *Oxford: Clarendon Press* (1953) 222 *pp.* [*Monographs on the Physics and Chemistry of Materials.*]

"Experimental techniques have recently been developed which enable the passage of elastic waves through solids to be observed directly. This monograph provides a summary of the classical theory of the propagation of such waves, and then considers how this theory can be extended to solids which are not perfectly elastic."

539.4.016.2

4422. Validity of Matthiessen's rule for cold-worked wires. W. BOAS AND J. F. NICHOLAS. *Austral. J. Phys.*, **6**, 116–21 (*March*, 1953).

Matthiessen's rule has been tested by determining the slopes of the electrical resistivity-temperature curves for wires of eight common metals and alloys in various states of deformation by wire-drawing. The results show that the slope is independent of deformation, i.e. the rule is true, to within 0·5% for Ni, Cu (two purities), Fe, and 80/20 brass and to within 1% for Al. However, for 75/25 brass and an Al bronze, deformations corresponding to logarithmic strains of 2·3 decrease the slopes by 1 and 3% respectively. As an explanation of this behaviour, it is suggested that deformation causes an increase in the characteristic temperature. A.

539.4.016.2

4423. The failure of Matthiessen's rule for heavily deformed alloys. P. G. KLEMENS. *Austral. J. Phys.*, **6**, 122–3 (*March*, 1953).

Deviations from Matthiessen's rule, such as were found by Boas and Nicholas (preceding abstract) for some heavily deformed alloys, may be explained by assuming that in the strongly disordered regions the thermal vibrations of the atoms contribute much less to the resistance than in perfect regions of the crystal. The magnitude of the calculated effect is compatible with the experimental results. A.

539.4.016.3 : 535.55

4424. Photoelastic studies of quenched cylinders and spheres. K. A. PARSONS. *J. appl. Phys.*, **24**, 469–72 (*April*, 1953).

A mathematical theory of residual stresses of quenching origin based on an idealized model of the quenching process is investigated. Photoelastic curves are computed from the theory and compared with those determined with a Babinet Compensator. Ten glass cylinders and spheres quenched in molten lead are employed. Although the qualitative agreement between theory and experiment is good, a quantitative comparison shows that the theory needs improvement. Major factors in the disagreement are probably the neglect of the effects of plastic flow and the temperature dependence of the physical constants. A.

539.43

4425. On the statistical interpretation of fatigue tests. A. M. FREUDENTHAL AND E. J. GUMBEL. *Proc. Roy. Soc. A*, **216**, 309–32 (*Feb.* 10, 1953).

Progressive damage under repeated load cycles which leads to spreading, visible fatigue cracks and finally to fracture in both metals and non-metals is a highly structure-sensitive process, the large-scale manifestations of which depend primarily on happenings on the submicroscopic and microscopic scale. This produces a considerable scatter in the results of fatigue tests performed under assumedly identical conditions. Thus, if n specimens are subjected to a sequence of stress cycles of the same amplitude S, they break at varying numbers of cycles; these numbers N taken in decreasing order, and the frequencies of survival at each number, determine, for each stress level S, a characteristic cumulative frequency distribution $l(N)_S$, the "survivorship function." By formulating the phenomenon of consecutive fatigue

fractures of the weakest within a finite (large) set of specimens as a problem of extreme values, the statistical theory of extreme values can be applied to the interpretation of the observed frequencies of survival at any stress amplitude. If, in first approximation, it is assumed that the probability of survival reaches unity only for $N = 0$ (no "sensitivity threshold" in N), the survivorship functions are reproduced by the "third asymptotic probability function of smallest values," which is represented on extremal probability paper by a straight-line relation between a reduced statistical variate y and $\log_{10} N$. Methods are presented for the computation of the two parameters of the survivorship function $l(N)_S$ from a set of fatigue data. The fit between the computed theoretical straight lines and the test results is satisfactory for fatigue tests of Cu, Al and a high-strength structural Al alloy. A.

539.43

4426. Structural changes during the fatigue of metals. F. P. BULLEN, A. K. HEAD AND W. A. WOOD. *Proc. Roy. Soc. A*, **216**, 332–43 (*Feb.* 10, 1953).

A combined X-ray diffraction and metallographic examination has been made of the structure of a metal subjected to cyclic stressing. The X-ray tests show that when a symmetrical cycle in tension-compression is built up slowly the grains break down on a widespread scale into disoriented elements. But when the same stress cycle is built up faster than a critical rate the disorientation is largely suppressed. The metallographic evidence indicates that there is a corresponding transition from a widespread to a highly localized distribution of the deformation zones in the grains, and the combined results show that there must be a "delay period" before the activation of the average slip movement. It is found, further, that, once a given stress cycle in excess of the safe fatigue limit is built up, continued cycles cause further movements which lead to the fatigue crack in the deformation zones. The movements do not continue when the cyclic stress is replaced by a static stress equal to the peak of the cycle, and they are attributed therefore to an enhancing of the atomic mobilities brought about in the deformation zones by the alternations of stress. It is shown, moreover, that the movements do not necessarily cause local strain-hardening and therefore do not occur by the usual slip mechanism of plastic flow, but more likely by a viscous motion. A.

539.434

4427. Low-stress torsional creep properties of pure aluminium. W. BETTERIDGE. Letter in *Bull. Inst. Metals*, **1**, 123 (*Oct.*, 1952).

A reply to comments [Abstr. 8509 (1952)] on a letter by the author [Abstr. 8508 (1952)]. X-ray examination showed no significant orientation differences between the specimens of different grain-size, and the possibility of the Jillson mechanism being operative appears to be ruled out by the fact that the structures all had a ⟨100⟩ fibre axis. The values of the transient and permanent creep coefficients deduced from the author's results, and used in the discussion, are disputed. A. J. KENNEDY

539.434 : 539.211

4428. Fatigue fracture from the standpoint of the stochastic theory. T. YOKOBORI. *J. Phys. Soc. Japan*, **8**, 265–8 (*March–April*, 1953).

In a previous paper [Abstr. 1952 (1953)] the author studied the statistical aspects of fatigue fracture. In this paper as a fundamental case experiments were carried out under the reversed tension and compression fatigue test. From the results the fluctuations of the number of repeated cycles to fracture were found to have marked characteristics, which are basic features of fatigue fracture. Theoretically the problems were treated as successive events such as of damage and fracture from the standpoint of the stochastic theory, and the theory is in good agreement with these experiments. Attempt has been made to interpret the physical meaning of the transition probability from the standpoint of rate process theory, and it seems to be understood as the reaction rate. A.

539.434 : 541.64

4429. Constant stress elongation of soft polymers: time and temperature studies. C. A. DAHLQUIST AND M. R. HATFIELD. *J. Colloid Sci.*, **7**, 253–67 (*June*, 1952).

Following the method of Andrews *et al.* [*J. Polymer Sci.*, **3**, 669 (1948)] "master curves" are given of log (reduced modulus) against log (reduced time) for creep data on polyisobutylene and GR–S rubber in the temperature range 40°C to −50°C. J. E. CAFFYN

539.501 : 612.1

4430. The rheology of blood. A survey. A. L. COPLEY. *J. Colloid Sci.*, **7**, 323–33 (*June*, 1952).

A survey with 53 references. J. E. CAFFYN

539.537

4431. Engravement of transient stress wave particle velocities. J. S. RINEHART AND J. PEARSON. *J. appl. Phys.*, **24**, 462–9 (*April*, 1953).

Quantitative information on the high intensity transient waves set up by impulsive loading is usually required in order to design rationally against failure under such loads. To obtain reliable data is often difficult when the loads last only a few microseconds and reach magnitudes of several hundred thousand pounds per square inch. A technique is described which enables quantitative determinations to be made either of particle velocity within the transient wave or of velocity of propagation of the wave. The scheme consists basically of measuring the depth of the permanent impression or engravement that is left on a surface when a pellet that has been previously affixed to that surface flies off. The engravement is a direct consequence of the impingement of a transient wave against the surface. Considerable numerical data are presented which establish the validity of the scheme. The simplicity of the technique suggests that it may find extensive application in impulsive investigations. A.

539.576 : 539.169

4432. Wear studies of irradiated carbide cutting tools. B. COLDING AND L.-G. ERWALL. *Nucleonics*, **11**, 46–9 (*Feb.*, 1953).

The wear of carbide tips of lathe cutting-tools was studied by measuring the transfer of β-activity to turning-chips. The tips were irradiated in a pile neutron flux and the activity utilized was 24 hr W^{187}. L. R. SHEPHERD

539.61 : 537.217

4433. Electrical phenomena in adhesion. I. Electron atmospheres in dielectrics. S. M. SKINNER, R. L. SAVAGE AND J. E. RUTZLER, JR. *J. appl. Phys.*, **24**, 438–50 (*April*, 1953).

Rapid breaks of metal-polymer-metal adhesive specimens have shown the presence of a charge density on the metallic surface, provided the break occurs at the metal-polymer interface, and a much smaller charge if it occurs in the interior of the polymer. This is analysed in terms of the electron atmosphere existing external to the metal in a dielectric region of low barrier. The barrier values in certain cases are otherwise known to be of appropriate order of magnitude. Measured experimental surface charge densities permit estimation of the maximum limit of barrier height. Because of the presence of the charge distribution in the polymer, there is an electrostatic force on the adherent metal directed toward the dielectric polymer, which represents a contribution to the total adhesive forces opposing break. Such electrostatic contributions to adhesion have not previously been considered; their order of magnitude and their relation to the thickness of the adhesive are discussed. The qualitative agreement between the theory and a number of previously unexplained experimental results in the literature is shown. A.

539.62

4434. On the looseness of wear fragments. E. RABINOWICZ. Letter in *J. appl. Phys.*, **24**, 367 (*March*, 1953).

An autoradiograph of the track made by a radioactive steel slider on a flat steel plate reveals wear fragments [Abstr. 9036 (1951)]. It remains substantially the same after mechanical shock to remove possible loose fragments. These facts provide support for the "welding" rather than the "mechanical interlocking" theory of friction [Abstr. 9101 (1952)].

J. W. MENTER

539.89 : 666

4435. Effects of very high pressures on glass. P. W. BRIDGMAN AND I. ŠIMON. *J. appl. Phys.*, **24**, 405–13 (*April*, 1953).

In contrast to other inorganic solids, glasses may be permanently compacted by application of pressures of the order of 10^4 to 10^5 atmospheres. This effect was studied on two simple oxide glasses (SiO_2 and B_2O_3) and several silicate glasses. The effect of compacting was studied by measuring the densities, dimensions and X-ray diffraction patterns. A definite threshold pressure is observed in vitreous silica and silicate glasses, under which no effect takes place and above which the collapse takes place readily. Vitreous boric oxide behaves in a different manner, collapsing gradually, starting at the lowest pressures. Vitreous boric oxide exhibits also plastic flow with subsequent strain hardening. X-ray diffraction measurements performed on vitreous silica and boric oxide indicate that the compacting proceeds on the atomic scale, leaving, however, the short-range order of the basic structural units unchanged. The density of compacted glass can be restored to the original value by annealing to sufficiently high temperatures. Activation energy of this process was determined in the case of vitreous boric oxide. A.

PHYSICAL CHEMISTRY 541

PHASE EQUILIBRIUM . CHEMICAL REACTIONS 541.11/.12

541.123.5 : 536.7

4436. Adsorption studies on clay minerals. II. A formulation of the thermodynamics of exchange adsorption. G. L. GAINES, JR AND H. C. THOMAS. *J. chem. Phys.*, **21**, 714–18 (*April*, 1953).

For Pt I, see Abstr. 3052 (1952). Expressions for thermodynamic equilibrium constants are set up for the ion-exchange equilibria of models defined in terms of operational variables. Formulae summarizing the methods for the computation of the requisite activity coefficients are given. In particular, the effects of the solvent, which is considered as an independently variable component, are taken explicitly into account. A.

541.124

4437. The pyrogenetic formation of ketones. R. I. REED. Letter in *J. chem. Phys.*, **21**, 377–8 (*Feb.*, 1953).

Presents preliminary results of an investigation on the decomposition of CH_3COONa. For measurements carried out at 420–500°C, the reaction, followed by the formation of Na_2CO_3, is of the order of 3/2 with respect to the salt for at least 60% of the reaction. The activation energy is nearly 50 kcal/mol. Pyrolytic decomposition experiments on isobutyric acid and Na isobutyrate are also described. F. LACHMAN

541.124

4438. Synthesis of cyclobutene-d_6 and cyclobutane-d_8. R. C. LORD. Letter in *J. chem. Phys.*, **21**, 378 (*Feb.*, 1953).

Describes a modification of the synthesis of Cope *et al.* adapted to the deuterium preparation. Some 7·0 g (0·12 mole) of cyclobutene-d_6 have been obtained by this procedure. Cyclobutane-d_8 is easily obtained from it by bromination and treatment with Zn in alcohol. F. LACHMAN

541.124

4439. A study of the $C_2H_4 + HCl = C_2H_5Cl$ and $C_2H_4 + HBr = C_2H_5Br$ equilibria. M. R. LANE, J. W. LINNETT AND H. G. OSWIN. *Proc. Roy. Soc. A*, **216**, 361–74 (*Feb.* 10, 1953).

The equilibrium constants of the two reactions $C_2H_4 + HX = C_2H_5X$, where X = Cl or Br, have been measured for X = Cl from 449 to 491°K, and for X = Br from 515 to 573°K. The methods of preparing and purifying the substances used, of carrying out the analyses and of determining the equilibrium constants have been described. The results for the ethyl chloride equilibrium were combined with

calculations of the entropy change using Gordon and Giauque's barrier height in ethyl chloride of 3700 cal/mole to obtain a value for the heat content change. The value for this, corrected to 298°K, is 17·1 kcal/mole. This leads to a heat of formation of ethyl chloride of −26·7 and a heat of dissociation of the C–Cl bond in ethyl chloride of 80·9 kcal/mole. For the ethyl bromide equilibrium, the entropy change was calculated using barrier heights in ethyl bromide of 3000, 4000 and 5000 cal/mole. Using the entropy changes calculated it was concluded that the heat of reaction, corrected to 298°K, is within 0·3 kcal/mole of 19·1. This leads to a heat of formation of ethyl bromide of −15·3 and a heat of dissociation of the C–Br bond in ethyl bromide of 67·2 kcal/mole. The two bond dissociation energies have been incorporated in the recent tables of Mortimer, Pritchard and Skinner listing such energies. The significance of the values for the bond dissociation energies in the series of *RX* molecules, where *R* = *Me*, *Et*, *n-Pr*, *n-Bu*, *iso-Pr* and *tert.-Bu*, and *X* = H, Cl and Br have been discussed. A.

541.124

4440. Adiabatic correlation rules for reactions involving polyatomic intermediate complexes and their application to the formation of $OH(^2\Sigma^+)$ in the $H_2 - O_2$ flame. K. E. SHULER. *J. chem. Phys.*, **21**, 624–33 (*April*, 1953).

The rules are presented together with some pertinent correlation tables. These permit the determination of the adiabatically allowed term manifold of reaction products from the states of the separated reactants without reference to their detailed electronic configurations. The formulation presented here utilizes group theoretical arguments relating to the symmetry properties of the reactants, the intermediate reaction complex, and the products and is based principally upon the results obtained previously by Mulliken for the resolution of species into those of point groups of lower symmetry. The effects of the change of the (geometrical) configuration of the intermediate reaction complex during reaction and of the electronic-vibrational coupling on these correlations have been considered in detail. It is concluded that strict orbital electronic correlation rules are operative only for reactions where neither the reactants nor the products are polyatomic. For reactions involving polyatomic reactants and/or products, the vibrational-electronic coupling weakens the simple orbital electronic correlations so that detailed vibronic correlations will be necessary. The spin correlation rules, however, are not affected by these interactions and are identical with those given by Wigner and Witmer for atomic and diatomic systems. These correlation rules are then applied to a study of the reactions

$$H + O_2 \rightarrow [HO_2] \rightarrow OH^* + O$$
$$O + H_2 \rightarrow [OH_2] \rightarrow OH^* + H$$

which may be of importance in the production of electronically excited $OH[OH(^2\Sigma^+)]$ in the hydrogen-oxygen flame. The mechanism of these reactions is investigated with special reference to the predissociating $OH(^2\Sigma^-)$ state discussed recently by Gaydon and Wolfhard [Abstr. 6376 (1952)]. It is suggested that the interaction of and the consequent radiationless transition between HO_2 intermediate reaction complexes is primarily responsible for the formation of $OH(^2\Sigma^+)$ in its observed vibrational non-equilibrium distribution with the specific enhancement of the levels $v' = 2$ and 3. The adiabatic correlations for the special case of association (and dissociation) reactions involving linear polyatomic intermediate complexes and products are considered briefly in the appendix. It is concluded that vibronic correlations are required for the determination of the product term manifold for these reactions. A.

541.126

4441. A theoretical model of a gaseous combustion wave governed by a first-order reaction. R. FRIEDMAN AND E. BURKE. *J. chem. Phys.*, **21**, 710–14 (*April*, 1953).

Numerical solutions are obtained for differential equations describing a hypothetical model of a laminar flame. A first-order irreversible reaction with approximately exponential dependence of rate upon temperature is assumed, with interdiffusion of reactant and product molecules. The temperature dependence of thermal conductivity, diffusion coefficient and gas density is taken into account. When the equations are in suitable form, the dimensionless burning velocity is an eigenvalue whose magnitude depends on two dimensionless parameters; ε (the ratio of activation energy to burned gas temperature) and α (the ratio of heat flow to diffusional flow). An I.B.M. Card-Programmed Electronic Calculator was used to obtain solutions accurate to 2%, for a wide range of values of ε and α. Interdiffusion is found to reduce the burning velocity, the effect being more pronounced when ε is large. The results for α equal to unity are compared with the approximate burning-velocity equation of Zeldovich and Frank–Kamenetsky, and the latter is shown to be valid only when ε is large. A.

541.127

4442. The rate of combination of methyl radicals. K. U. INGOLD AND F. P. LOSSING. Letter in *J. chem. Phys.*, **21**, 368 (*Feb.*, 1953).

The rate constant of the reaction $2CH_3 \rightarrow C_2H_6$ was determined. The radicals were formed by thermal decomposition of mercury dimethyl in a stream of helium, and their concentration was analysed by a mass spectrometer. The contact time was varied by changing the distance between furnace and orifice. The combination proceeds by both a first-order and a second-order reaction. The latter has a negative temperature coefficient. No total pressure effect was found. The results for the various temperatures and pressures are tabulated. A. J. TAYLOR

541.127

4443. A quantum-mechanical calculation of the rates of some chemical reactions. E. BAUER AND T.-Y. WU. *J. chem. Phys.*, **21**, 726–33 (*April*, 1953).

The rates of many simple chemical reactions of the type $AB + C \rightarrow A + BC$ are empirically known to be of the form $k_{OF} = PZ \exp(-E_A/kT)$. On the theory that the reactions take place through the interchange of translational and vibrational energy, a

qualitative quantum mechanical calculation of the rate k_{OF} is made for the simple model of collinear collisions. The empirical values of the activation energy E_A are employed to fix the interaction potential for a given reaction. On identifying the quantum-mechanical expression for the rate k_{OF} with the empirical expression above and on using the gas kinetic expression for the mean number of collisions Z, it is possible to calculate the probability factor P. Numerical calculations have been carried out for the two reactions $H_2 + X \rightarrow HX + H$, where X is Cl or Br. In both cases, P is found to be about 8×10^{-3}. A.

541.127

4444. Kinetics of two exchange reactions involving diborane. P. C. MAYBURY AND W. S. KOSKI. *J. chem. Phys.*, **21**, 742–7 (*April*, 1953).

The kinetics of the exchange between deuterium and diborane were studied over a temperature range of 25°–75°C, and it was found that the reaction was $\frac{3}{2}$ order with respect to diborane and zero order with respect to deuterium at high pressures. At low pressures the zero-order dependence of the deuterium changed to first-order. The activation energy of the zero-order reaction was $20{\cdot}4 \pm 2$ kcal/mole. A mechanism is proposed in which the borine radical reacts with deuterium on the wall and is followed by a rate-determining bimolecular collision between the partially deuterated borine radical and a diborane molecule. The closely related exchange reaction between normal and completely deuterated diborane was also investigated. The total order of this reaction was $\frac{3}{2}$, and it had an activation energy of $21{\cdot}8 \pm 3$ kcal/mole. A mechanism is proposed which involves the collision between a borine radical and a diborane molecule as the rate-determining step. A.

ELECTROCHEMISTRY 541.13

541.133 : 532.133

4445. An extension of the theory of the conductivity and viscosity of electrolyte solutions. E. PITTS. *Proc. Roy. Soc. A*, **217**, 43–70 (*March* 24, 1953).

In the theories of the conductivity and viscosity of electrolyte solutions originally developed by Debye and Hückel (1923), and Falkenhagen and his co-workers (1928), the ions were regarded as dimensionless point charges. In the theory of activity and osmotic coefficients developed by Gronwall, La Mer and Sandved (1928) the ions were assumed to be of finite size, having a distance of closest approach, a. Making use of the Gronwall *et al.* results, the concept of closest approach has been introduced into the theories of conductivity and viscosity. These quantities are obtained in the form of infinite series, of which only the first few terms have been calculated, owing to the great complexity of the work. In the case of conductivity, for 1-1 salts in water the approximate range of validity of the results is for concentrations less than N/10. Complete quantitative agreement with experiment is found. Under other experimental conditions the calculated conductivity shows the correct qualitative behaviour. The new theory of viscosity should possess a similar range of validity, but comparison with experiment shows that the treatment gives no improvement on the Falkenhagen results. In their paper, Gronwall *et al.* gave only a very limited comparison between their theory and experiment. It has been necessary to extend this comparison, and values of a found thereby are compared with those obtained from the new theory of conductivity. The significance of these values is discussed together with reasons for the success of the conductivity theory and the absence of any improvement in the viscosity theory. A.

541.135.5

4446. Calculation of the concentration of atomic hydrogen at a cathode. J. O'M. BOCKRIS AND R. PARSONS. Letter in *J. chem. Phys.*, **21**, 569 (*March*, 1953).

Salzberg and Schuldiner [Abstr. 510 (1953)] have criticized the equation of Bockris *et al.* [Abstr. 6846 (1952)], viz. $i = 2F(kF/h)10^{-18}x^2 \exp[-\Delta G^{\ddagger}/RT]$, as dimensionally incorrect and lacking a probability factor. It is now shown that this apparent absence of a probability term is due to its inclusion within the entropy of activation, which is one of the components of the standard free energy of activation, FG^0. It is emphasized, that $\Delta G^{\ddagger}$ is the standard electrochemical free energy of formation of the activated complex from the reactants, since Salzberg and Schuldiner apparently confuse this quantity with the difference in zero point energies between the initial and activated states. The occurrence of a limiting current at c.d. ~ 10 amp. cm^{-2} in pure acid solutions during hydrogen evolution at Pt electrodes, is explained on the assumption of the surface approaching saturation by adsorbed hydrogen at this c.d.; the further increase of current which occurs at higher potentials is due to the occurrence of a desorption mechanism alternative to the surface combination of atoms. H. H. HODGSON

PHOTOCHEMISTRY . RADIATION CHEMISTRY 541.14/.15

541.14

4447. The photochemical and thermal decompositions of hydrogen sulphide. B. DE B. DARWENT AND R. ROBERTS. *Proc. Roy. Soc. A*, **216**, 344–61 (*Feb.* 10, 1953).

The photochemical decomposition has been investigated at pressures between 8 and 550 mm Hg and at temperatures between 27 and 650°C, using the narrow Cd line (λ2288) and the broad Hg band (about λ2550). At room temperature the quantum yield increases with pressure from 1·09 at 30 mm to 1·26 at 200 mm. Above 200 mm pressure there was no further increase in the quantum yield. Temperature had little effect on the quantum yield at λ2550, but there was a marked increase in the rate of H production between 500 and 650°C with 2288 Å radiation. This may have been caused by the decomposition of excited hydrosulphide radicals. The results are consistent with a mechanism involving H atoms and hydrosulphide radicals. The Hg-photosensitized reac-

tion is less efficient than the photochemical decomposition, the quantum yield being only about 0·45. The efficiency increased with temperature and approached unity at high temperatures and pressures. This agrees with the suggestion that a large fraction of the quenching collisions lead to the formation of $Hg(^3P_0)$ atoms. The thermal decomposition is heterogeneous at low temperatures and becomes homogeneous and of the second order at 650°c. The experimental evidence suggests the bimolecular mechanism $2H_2S \rightarrow 2H_2 + S_2$. The activation energies are 25 kcal/mole (heterogeneous) and 50 kcal/mole (homogeneous). A.

541.14

4448. The production of organic free radicals by light. G. Oster and H. Mark. *J. Opt. Soc. Amer.*, **43**, 283–9 (*April*, 1953).

It has long been known that molecules can be dissociated by light to produce free radical type fragments, which can cause a series of secondary reactions. Significant progress has recently been achieved by Melville and Norrish in applying high radiation intensities and short time electronic recording devices. It was possible to produce free radicals in sufficient concentrations to photograph their absorption spectrums and to determine their average lifetime in the presence of various substances with which they react. A.

541.14 : 537.312.5

The Becquerel effect in the presence of dyestuffs and the action of light in dyes. *See Abstr.* 4103

541.15

4449. Radiation induced by alpha-particles in thin films. A. Norman, M. A. Greenfield and P. M. Kratz. Letter in *Nature* [*London*] **171**, 487 (*March* 14, 1953).

Thin films of collodion, deoxyribonucleic acid, Al, Au and Cu, built up by evaporation on to quartz to a thickness small compared with the range of the α-particles used, were placed in front of the slit of a quartz spectrograph and exposed to a 25 mc Po source. The spectra recorded show that each film, when bombarded by α-particles, emitted radiation in a continuum from 2300 to 4700 Å. The spectra also contain bands due to air and to O bound to the Po. These are listed. Po dissolved in water gave the same spectrum, so that there is no radiation in this range from the water under α-particle bombardment.

C. B. Allsopp

541.15

4450. The decomposition of nitrate crystals by ionizing radiations. G. Hennig, R. Lees and M. S. Matheson. *J. chem. Phys.*, **21**, 664–9 (*April*, 1953).

Sodium nitrate, potassium nitrate, and potassium chlorate have been exposed two to four weeks in the experimental thimble of the Argonne Heavy Water Pile. After exposure these salts evolve a gas when dissolved in water or when melted or heated to a crystal transition point. The gas yields are in sodium nitrate ~0·3, in potassium nitrate ~0·8 and in potassium chlorate 2·0–3·0 molecules gas/100 eV. For the nitrates this gas has been shown to be largely oxygen which is trapped during irradiation in the gaseous form in small pockets in the crystal. This conclusion is based on the paramagnetism of irradiated crystals, on chemical analysis of evolved gases and on measurements of the amounts gas liberated in crushing experiments. When irradiated crystals are heated below the melting poi the gas pockets grow and coalesce, this being accoc panied by a decrease in crystal density. In irradiat nitrates, oxygen and nitrite ion are formed in eq valent amounts. Experiments with low ener X-rays indicate that most of the decomposition resu from electronic ionization and excitation and not fr elastic collision of the bombarding particles.

DISPERSIONS . COLLOIDS . ADSORPTIC

541.18

541.18.047

4451. The effect of the electric charge distribution the ageing of an aerosol. T. Gillespie. *Proc. Rc Soc. A*, **216**, 569–82 (*Feb.* 24, 1953).

Smoke-chamber experiments have been carried o to determine the electric charge distributions and t constants descriptive of coagulation and surface lc of aerosols of porous silica powder, magnesium oxi and ammonium chloride. The data obtained we used to test the hypothesis that the rate of coagulatic is affected by the electric charge distribution. Calcul tions have been made of the effect of electric charg on the particles of an aerosol on its rate of coagulatic due to Brownian movement, differences in gravit tional settling and turbulence. A simple expressic for the coagulation constant was obtained which w found to be a function of the fraction of positi particles, the fraction of negative particles, th average particle charge of each sign and the avera radius. A more exact treatment of ageing data tha has previously been presented indicated a possib variation in the coagulation and surface loss constan with time, and this variation has been shown to b related to changes in the electric charge distributio

541.18

4452. The accommodation coefficient techniqu applied to a study of molecular oxygen film on tungste J. L. Morrison and W. E. Grummitt. *J. chem. Phys* **21**, 654–9 (*April*, 1953).

The accommodation coefficient method of Rober was used to measure the adsorption isotherms of th upper molecular O film on W at 25 and 100°c and a pressures from 9×10^{-9} to 1×10^{-4} mm Hg. The iso therms were found to fit Wang's theoretical isotherr for a mobile film with repulsive interaction. A entropy of adsorption was calculated from the surfac pressure by Hill's method and found to be about fou entropy units at low film concentrations. The larg discrepancy between calculated and theoretical en tropies suggests either or both irreversible effects an non-linearity of the relation between accommodatio coefficients and surface coverage. The minima whic are exhibited during the growth with time of th adsorbed film at 100°c may be direct evidence for th presence of holes in the immobile first layer which ar filled by activated diffusion from the upper layer. A

541.183 : 537.226.2

4453. Dielectric properties of vapors adsorbed on silica gel. I. K. KAMIYOSHI. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **3**, 513–22 (*Aug.*, 1951).

Utilizing the formula for determining the dielectric constant of powder dielectrics and Debye's method for the determination of the dipole moment of liquid by dilute solution, the dipole moment of several kinds of vapours adsorbed on silica gel were determined. Results show that at earlier stage of adsorption, the dielectric properties of adsorbed vapour are generally equal to that of free gaseous state, and that the behaviour of the change of dipole moment with the increase in sorbed amount may be classified into three kinds: (i) $\mu_g > \mu_l$, (ii) $\mu_g = \mu_l$, (iii) $\mu_g = \mu_l = 0$, where μ_g is the dipole moment of gaseous state and μ_l is that calculated by inserting in Debye's equation the dielectric constant and refractive index of the liquid state at a given temperature. A.

CHEMICAL STRUCTURE 541.2/.6

541.64 : 535.345–31

Ultra-violet absorption by high polymers. *See Abstr.* 4024

541.64 : 539.31

4454. Stress relaxation in elastomers. A. M. BUECHE. *J. chem. Phys.*, **21**, 614–16 (*April*, 1953).

The process of chemical stress relaxation in elastomers is examined in some detail. It is predicted that in some cases it will be possible to determine the location of the chemical bond broken. The special cases of relaxation due to scission of cross links and random scission of the polymer are calculated. The shapes of the stress *v.* time curves are widely different. A.

541.66

4455. The effect of cross-linking on the density and melting of Polythene. A. CHARLESBY AND M. ROSS. *Proc. Roy. Soc. A*, **217**, 122–35 (*March* 24, 1953).

The density of Polythene has been studied in relation to temperature and the degree of cross-linking produced by pile irradiation. Cross-linking results in a progressive reduction in the percentage of crystalline material at room temperature. The transition temperature corresponding to melting in ordinary Polythene is only very slightly decreased with increasing cross-linking, so that the temperature at which all crystalline structure vanishes is little affected. However, because of the reduced amount of crystalline material present in the cross-linked polymer, the magnitude of the change in density at the transition temperature is considerably lessened. There are certain anomalies between the transition temperature deduced from density measurements and from other methods. The density of cross-linked Polythene in the amorphous state is found to obey a law very similar to the Van der Waals law for gases:

$$\left[P + \frac{P_0}{1 - \beta(c)}\right][V(c) - V_0] = \frac{RT}{M}$$

where P_0 is the internal pressure arising from binding forces and V_0 is a constant corresponding to a "residual" volume per gram at 0°K; both are independent of the degree of cross-linking c. P represents the external pressure, $V(c)$ the specific volume (or volume per gram) of cross-linked polymer and M the molar weight 28 (—CH_2—CH_2—). $\beta(c)$ is a function approximately equal to c. A.

CHEMICAL PROCESSES 542.9

542.943

4456. The oxidation of iron around 200°C. W. H. J. VERNON, E. A. CALNAN, C. J. B. CLEWS AND T. J. NURSE. *Proc. Roy. Soc. A*, **216**, 375–97 (*Feb.* 10, 1953).

Phenomena associated with a critical temperature at ~200°C in the oxidation of mild steel sheet in air (for example, a change of slope in the curve relating reciprocal of absolute temperature with logarithm of O uptake in constant time) have been investigated by gravimetric, microchemical and electron-diffraction methods. The evidence is interpreted on the basis of predominant metal-ion diffusion above and predominant O-ion diffusion below 200°C, in the oxide film. In the film an outer layer of rhombohedral α-Fe_2O_3 overlies a layer of cubic oxide which, initially nearer γ-Fe_2O_3, tends towards Fe_3O_4—rapidly and completely above 200°C, slowly and incompletely below 200°C. Above 200°C the rate of oxidation is controlled by the diffusion of ions across the film (Wagner mechanism), the parabolic law is followed, and O uptake derived from the weight increase of the specimen is coincident with the O content of the film on removal from the substrate. The film, being produced outside the original metal/air interface, is relatively insensitive to the mode of preparation of the surface, and interface colours readily develop. Below 200°C, oxidation again involves ion diffusion across the film, but the rate is controlled by a boundary reaction with a consequent logarithmic relationship with time. Since oxidation now proceeds at an oxide-metal interface the optical homogeneity of the oxidized layer is very sensitive to the initial condition of the surface. Abraded surfaces carry initially a heterogeneous layer (abrasion-produced oxide in a matrix of Fe) in which oxidation can proceed without contributing to the overlying (strippable) film on which the development of interference colours depends. Thickening of the film and progression of colours may be long delayed during the period of O uptake within the substrate. This period may be eliminated or reduced either by removal of the heterogeneous layer by acid etching or by its modification by vacuum annealing. Although the disturbed substrate on abraded specimens serves in this way to provide evidence for the inward diffusion of O, it exerts no appreciable control over the total O uptake either above or below 200°C. A.

542.952.6

4457. Studies in polymerization. VI. Acrylonitrile: the behaviour of free radicals in heterogeneous systems. C. H. BAMFORD AND A. D. JENKINS. *Proc. Roy. Soc. A*, **216**, 515–38 (*Feb.* 24, 1953).

For Pt V, see Abstr. 7380 (1949).

542.952.7

4458. Thermal degradation of polystyrene. P. D. ZEMANY. Letter in *Nature* [*London*] **171,** 391–2 (*Feb.* 28, 1953).

Describes an experiment on the degradation of thermally polymerized styrene, using an analytical mass spectrometer. Solvent (benzene) persisted for a very long time; presence of acetic acid and methyl-*cyclo*-hexane cannot be explained. Activation energies for the production of C_6H_6, $C_6H_5CH_3$ and styrene have been derived, and the rate of production of styrene calculated. F. LACHMAN

CHEMICAL ANALYSIS 543/545

545.8

4459. The scope of radioactivation analysis. A. A. SMALES. *Atomics* [*London*] **4,** 55–63, 74 (*March,* 1953).

The use of induced radioactivity to facilitate analysis is described and recommended. Principles, methods and limitations are discussed and a bibliography is given. F. R. HOLT

545.8 : 535.371

4460. The fluorimetric determination of uranium in ores. I. DRAGANIĆ. *Receuil Trav. Inst. Rech. Struct. Matière* [*Belgrade*] **1,** 89–94 (*July,* 1952) *In German.*

Details of a simple fluorimeter are given. The samples and standard specimens are exposed simultaneously to unstabilized u.v. radiation, and the fluorescing materials are photographed. The blackenings on the photographic plates are compared photometrically. S. WEINTROUB

545.824

4461. The quantitative determination of quartz by X-ray diffraction. R. L. GORDON, O. G. GRIFFIN AND G. NAGELSCHMIDT. *Safety Mines Res. Establ. Res. Rep., No.* 52, 25 *pp.* (*Oct.,* 1952).

The Debye–Scherrer method is used with MgO as internal standard; line intensities are measured by means of a recording microdensitometer. As the quartz lines used are only of medium strength the method is unsatisfactory for samples containing less than 10% of quartz. Results for fifty shale samples are given and compared with determinations of free silica by chemical methods. In studying the effect of the particle size of quartz it was found that fractions below 2 microns showed low line intensities which were not due to line broadening. If part of the samples was dissolved in hydrofluoric acid the residues gave normal intensities. This is taken as evidence for the presence of a layer of amorphous silica of about 300 Å thickness on the surface of each quartz particle. A.

CRYSTALLOGRAPHY 548

548.2

4462. Light figures of bismuth single crystals and the determination of their crystal orientations by the light-figure method. I. Preliminary investigations. M. YAMAMOTO AND J. WATANABÉ. *Sci. Rep. Res. Insts Tôhoku Univ. A,* **4,** 127–38 (*April,* 1952).

The general nature of the light-figure phenomenon in trigonal Bi single crystals was studied. Light figures produced by the {111} planes are always observed, while light figures corresponding to the $\{1\bar{1}1\}$ planes are created only by artificially prepared imperfect cleavage planes. Besides the {111} and $\{1\bar{1}1\}$ light figures, three kinds of light figure corresponding to high-index crystal planes {*uuv*}, {*uuv*} and {*uuw*} are observed. Crystallographic indices of $\{uu\bar{v}\}$, {*uuv*} and {*uuw*} planes were found to be $\{44\bar{1}$ or $55\bar{1}$ or $66\bar{1}\}$, {449 or 337} and {115}, respectively, though they change slightly with etching condition. Accounts are also given of the procedure for determining angles between normals of various crystal planes by the measurement of angles between symmetric centres of light figures corresponding to those planes and of the calculation of angles between normals of various crystal planes in Bi crystal. A.

548.5

4463. On the production of single crystals of zinc, bismuth and tin by sucking up from their melts. M. YAMAMOTO AND J. WATANABÉ. *Sci. Rep. Res. Insts Tôhoku Univ. A,* **3,** 165–74 (*April,* 1951).

Simple equipment was used and the effect of growing conditions upon the percentage of success and orientations of single crystals produced was studied. Single crystals, 5 mm in dia. and 5 ~ 7 cm in length, could be made with 20, 50 and 50% success for Zn, Bi and Sn, respectively, and they show a dominant preference of crystal orientations nearly perpendicular to the principal crystallographic axis, namely, the hexagonal axis [0001] for Zn, trigonal axis [111] for Bi, or tetragonal axis [001] for Sn. A.

548.5

4464. A note on the preparation of spherical single crystals of low melting metals. M. YAMAMOTO AND J. WATANABÉ. *Sci. Rep. Res. Insts Tôhoku Univ. A,* **3,** 655–6 (*Dec.,* 1951).

A brief account is given of the simple procedure for preparing spherical single crystals of Bi, Sn and Zn by the Tammann and Bridgman methods with glass moulds having spherical swellings at the bottom. A.

548.5

4465. Spiral growth of thymol crystals from solution and melt. E. VOTAVA, S. AMELINCKX AND W. DEKEYSER. Note in *Naturwissenschaften,* **40,** *No.* 4, 143 (1953).

Photographs showing growth pits on thymol crystals grown from solutions of CS_2 and CCl_4 and apparent cracks, together with an interferogram indicating growth layers of order of 5000 Å, are given. An explanation of the pits and cracks based on the bad thermal conduction of the crystals is advanced. S. WEINTROUB

548.5

4466. Diffusion problems associated with the growth of crystals from dilute solution. A. SEEGER. *Phil. Mag.*, **44**, 1–13 (*Jan.*, 1953).

Crystals growing from solutions with plane faces must have considerable supersaturation at some parts of the surface. A supersaturation number σ is introduced to give a measure of the maximum supersaturation. For two-dimensional growth in very dilute solutions a general method for evaluating σ is given; it is applied to the growth of regular polygons, to the growth of a step on a surface, and to growth on the edge of a plate. For three-dimensional growth only a rough estimate for the supersaturation occurring with regular polyhedra can be given; it is estimated that the maximum supersaturation on the surface of a cube or regular octahedron is between 0·25 and 0·4 of the concentration difference between the vertices and infinity. A.

548.5

4467. The surface of beryl and cadmium iodide crystals. H. F. KAY AND B. APPELBE. Letter in *Phil. Mag.*, **44**, 105–6 (*Jan.*, 1953).

Electron micrographs show that the high optical visibility of the spiral unimolecular steps on the prism faces of beryl is due to a high concentration of pits near the step edges. No such concentration occurs along the multimolecular steps on the basal plane. The growth spirals on cadmium iodide crystals have step heights of up to 2000 Å, and are centred on hexagonal holes. R. S. PEASE

548.5

4468. Growth of metal whiskers. S. E. KOONCE AND S. M. ARNOLD. Letter in *J. appl. Phys.*, **24**, 365–6 (*March*, 1953).

Electron microscope silhouette pictures of tin whiskers [Compton, Mendizza and Arnold, *Corrosion*, **7**, 327 (1951)] show that whiskers grow by addition of material at base. J. W. MENTER

548.5 : 535.515

4469. Growth and optical properties of stearic acid crystals. P. M. REYNOLDS AND A. R. VERMA. Letter in *Nature* [*London*] **171**, 486–7 (*March* 14, 1953).

Screw dislocation growth spirals in stearic acid crystals are described. Step heights are measured interferometrically and are shown to be multiples of the unit lattice parameter and some steps are recorded which have half integral multiples of the X-ray repeat units. The birefringence has been determined interferometrically using fringes of equal chromatic order. S. TOLANSKY

548.538

4470. Electron diffraction investigation of the actions of aqueous heavy metal salts on mineral surfaces. I. Action of silver nitrate and sulfate on sphalerite cleavage face. R. SATO. *J. Phys. Soc. Japan*, **8**, 152–8 (*March–April*, 1953).

In order, on the one hand, to accumulate data on crystal overgrowth on single crystal surfaces in solid-liquid systems, and, on the other, to elucidate the mechanism involved in activation of sphalerite by heavy metal salts in flotation, electron diffraction investigation has been carried out on the action of Ag nitrate and sulphate of comparatively low concentrations upon sphalerite cleavage face. Three kinds of surface products have been revealed: acanthite (Ag_2S), metallic Ag and Ag carbonate. It is noteworthy that the produced acanthite crystallites assume a certain epitaxial orientation with respect to the substrate even at room temperatures. In addition, it has been shown that the ageing of the surface products in a dry atmosphere results in the growth of the acanthite crystallites and the disappearance of the Ag. A.

MOLECULAR AND X-RAY CRYSTALLOGRAPHY 548.7

548.7

4471. Instability and melting of the alkali halides. J. H. C. THOMPSON. *Phil. Mag.*, **44**, 131–40 (*Feb.*, 1953).

A condition for instability of the thermal vibrations of an expanded lattice of the NaCl type is established. It is found that the instability occurs when the increase of interionic distance, as compared with that at 0°K under no stress, is between 6% and 7%. The thermal expansion to the melting point is computed for five alkali halides and found to be some 5%. The type of instability and its relation to melting are discussed. A.

548.7

4472. Approximate elastic spectrum of acoustic waves in AgCl from X-ray scattering. H. COLE. *J. appl. Phys.*, **24**, 482–7 (*April*, 1953).

The temperature diffuse scattering of X-rays from a large single crystal of AgCl has been measured at room temperature using a Geiger counter spectrometer and crystal monochromated Cu $K\alpha$ radiation. Measurements were made throughout the $hk0$ plane in reciprocal space, and in certain other regions. The data are analysed on the basis of the theory developed by Laval and James, in which temperature vibrations are expressed in terms of travelling elastic waves. An assumed set of vibrational frequencies is used for the optical branch. Dispersion curves for waves in the acoustical branch travelling in the [100], [110] and [111] directions are obtained. The velocities at infinite wavelength are shown to agree fairly well with those given by the static elastic constants. An approximate frequency spectrum is then calculated, and suggestions are made as to how the effects of the optical and acoustical branches may be separated. A.

548.7

4473. The occurrence of singularities in the elastic frequency distribution of a crystal. L. VAN HOVE. *Phys. Rev.*, **89**, 1189–93 (*March* 15, 1953).

It is shown that for a crystal, under the assumption of harmonicity for the interatomic forces and as a consequence of the periodic structure, the frequency distribution function of elastic vibrations has analytic singularities. In the general case, the nature of the singularities depends only on the number of dimensions of the crystal. For a two-dimensional crystal, the distribution function has logarithmically infinite peaks. In the three-dimensional case, the distribution function itself is continuous whereas its first derivative

exhibits infinite discontinuities. These results are elementary consequences of a theorem of Morse on the existence of saddle points for functions defined on a torus. A.

548.7 : 539.11

On the lattice vibrations of a binary superlattice alloy. *See Abstr.* 4244–5

548.7

4474. On the motion of electrons in non-sinusoidal periodic fields. T. S. KOUVELITES. Letter in *Proc. Phys. Soc.* [*London*] *A*, **66**, 197–8 (*Feb.*, 1953).

An investigation of electronic states in a one-dimensional crystal on the assumption of a sinusoidal potential function of period a to which was added either (i) a harmonic component of period $\frac{1}{2}a$, or (ii) a subharmonic component of period $2a$. With the ratios of the amplitudes fixed in both cases at 0·4, a small change in band structure was found in case (i), but a marked change occurred in case (ii).

P. T. LANDSBERG

548.7

4475. The motion of slow electrons in a polar crystal. T. D. LEE, F. E. LOW AND D. PINES. *Phys. Rev.*, **90**, 297–302 (*April* 15, 1953).

A variational technique is developed to investigate the low-lying energy levels of a conduction electron in a polar crystal. Because of the strong interaction between the electron and the longitudinal optical mode of the lattice vibrations, perturbation-theoretic methods are inapplicable. The technique, which is closely related to the "intermediate coupling" method introduced by Tomonaga, is equivalent to a simple canonical transformation. The use of this transformation enables the wave functions and energy levels to be obtained quite simply. Because the recoil of the electron introduces a correlation between the emission of successive virtual phonons by the electron, the approximation, in which this correlation is neglected, breaks down for very strong electron-phonon coupling. The validity of the approximation is investigated and corrections are found to be small for coupling strengths occurring in typical polar crystals. A.

548.7

4476. Self energy of slow electrons in polar materials. M. GURARI. *Phil. Mag.*, **44**, 329–36 (*March*, 1953).

A new variational method is developed to treat the properties of slow electrons in ionic crystals, and similar problems. It is shown that the true energy of the ground state is always lower than the energy obtained from second order perturbation theory, however strong the interaction. The corresponding wave functions differ, however, from those of perturbation theory unless the interaction is sufficiently weak. For NaCl the energy of the ground state is found lower than by any previous method, and hence closer to the true energy. The effective mass is of the order of twice the electronic mass; no trapping takes place, therefore. A.

548.7

4477. The calculation of *F*-center energy levels. J. A. KRUMHANSL AND N. SCHWARTZ. Letter in *Phys. Rev.*, **89**, 1154–5 (*March* 1, 1953).

It is pointed out that it is probable that the polarization of the medium can follow the position of the *F*-centre electron and, if so, the potential well for the electron trapped at the centre is deeper than has been hitherto assumed. Calculations for NaCl and KCl based on this hypothesis give better agreement with experiment than that obtained by previous calculations. L. PINCHERLE

548.7

4478. Color centers and trapped charge in KCl and KBr. D. DUTTON AND R. MAURER. *Phys. Rev.*, **90**, 126–31 (*April* 1, 1953).

Potassium chloride and bromide crystals have been irradiated with X-rays at −183°c and the behaviour of the V_1, F and F' optical absorption bands observed during subsequent warming to room temperature. The thermal bleaching of the V_1 band is accompanied by a decrease in the F band, the appearance of free charge within the crystal and luminescence. The data indicate that positive holes are released from traps during this process. A.

548.7

4479. The equation of motion of a dislocation. J. D. ESHELBY. *Phys. Rev.*, **90**, 248–55 (*April* 15, 1953).

The elastic field surrounding an arbitrarily moving screw dislocation is found, and a useful analogy with two-dimensional electromagnetic fields is pointed out. These results are applied to a screw dislocation accelerating from rest and approaching the velocity of sound asymptotically. The applied stress needed to maintain this motion is found on the assumption that the Peierls condition is satisfied near the centre of the dislocation. A general integral equation of motion is derived for a simplified dislocation model and the kind of behaviour it predicts is illustrated. A.

548.7

4480. The interaction of dislocations and boundaries. A. K. HEAD. *Phil. Mag.*, **44**, 92–4 (*Jan.* 1953).

The image forces on a screw dislocation due to a grain boundary, or a free surface on which is a surface film, are evaluated. For the case of an oxide layer on aluminium it is shown that there is an equilibrium position for the dislocation, at a depth in the metal approximately equal to the thickness of the oxide film. The behaviour of an edge dislocation is approximately the same. A.

548.7

4481. Domain structure of Rochelle salt and KH_2PO_4. T. MITSUI AND J. FURUICHI. *Phys. Rev.*, **90**, 193–202 (*April* 15, 1953).

It has been verified by means of the polarization microscope that Rochelle salt in the ferroelectric state consists of many domains. The domain structure in an annealed crystal is caused by the electrostatic self-energy. When the electric field along the X direction is increased and then decreased gradually, successive positions of the domain wall produce a hysteresis loop which proves the existence of a restoring force on the wall. This restoring force causes lag of charging, and its variation with time produces a fatigue effect. The propagation velocity of a domain wall is about 0·2 cm/sec for 100 V/cm. A group of domains parallel to the b axis has been created artificially

When a stress Y_z is applied, a set of domains inverts its polarization direction. Z-cut specimens of KH_2PO_4 cooled below the Curie temperature divide into many regions which appear to be domains. The phase transition in KH_2PO_4 propagates from only one nucleus. Theoretically it has been concluded that the domain wall energy of Rochelle salt is $1{\cdot}4\times10^{-10}P_0^3$ ergs/cm^2 and the wall width $\sim 2\times10^{-4}/P_0$ cm, where P_0 is the saturation polarization. A.

548.7 : 539.133

A nuclear magnetic resonance investigation of solid *cyclo*hexane. *See Abstr.* 4267

548.73/.74 : 539.26/.27

X-ray and electron investigation of materials. *See Abstr.* 4409–15

548.733

4482. A versatile X-ray camera for low-angle diffraction studies. J. B. FINEAN. *J. sci. Instrum.*, **30,** 60–1 (*Feb.*, 1953).

The camera employs the principles given by Bolduan and Bear [Abstr. 2775 (1950)]. It has a set of slits ranging in width from 0·05 mm to 0·30 mm, which can be interchanged without disturbing the alignment. A. R. STOKES

548.734.4

4483. Rotating-crystal methods. F. HUERTA. (*Instituto de Fisica Alonso de Santa Cruz, Madrid*) *Madrid* (1952) 108 *pp. In Spanish.*

The theory of X-ray diffraction methods using coupled movements of crystal and film is described, and results are given in the form of charts. The methods described are those of Weissenberg, Sauter, de Jong and Bouman, and Schiebold, and also two devised by the author. A. R. STOKES

548.736.3

4484. The ionic state of LiH. J. M. BIJVOET AND K. LONSDALE. *Phil. Mag.*, **44,** 204–7 (*Feb.*, 1953).

Several workers have independently measured the X-ray diffraction effects from LiH, and have obtained consistent intensity data. Such measurements, contrary to previous claims, cannot be used to determine the state of ionization of the atoms in the crystal. A.

548.736.4 : 539.11

4485. Study on the superlattices of ternary alloys by X-ray. S. OGAWA AND Y. MATSUZAKI. *Sci. Rep. Res. Insts Tôhoku Univ. A*, **3,** 50–4 (*Feb.*, 1951).

The ternary system of Fe–Al–Si, which contains the industrially important ferromagnetic alloy "Seudust" and has two superlattices of the same type on the Fe–Al and Fe–Si sides, offers various interesting problems in connection with the superlattice theory. The present work was undertaken in this ternary system to confirm by X-ray a composition-range in which the superlattice of the 3 : 1 type can exist, because no work had yet been reported concerning it. The result showed that all ferromagnetic singularities were found in this composition range. A.

548.736.5

4486. Crystal structure of a mixed salt of potassium chromate and potassium permanganate. E. STANLEY. Letter in *Research*, **5,** 589–90 (*Dec.*, 1952).

Rhombohedral cell, $a = 7{\cdot}8$ Å, $\alpha = 43{\cdot}2°$, containing $K_2CrO_4.KMnO_4$. The atomic arrangement is described. It has pseudo-symmetry $R\bar{3}m$ and the statistical distribution of intensities [Abstr. 6171 (1950)] agrees with that expected from a centrosymmetric structure. A. R. STOKES

548.736.5

4487. Crystal structure of the Ba, Sr and Ca triple carbonate. J. TERADA. *J. Phys. Soc. Japan*, **8,** 158–64 (*March–April*, 1953). Abridged version in *Nature* [*London*] **171,** 517–18 (*March* 24, 1953).

Crystal structures of the co-precipitated triple carbonates of Ba, Sr and Ca were studied by X-ray powder methods using an X-ray Geiger counter spectrometer. There exist three kinds of solid solutions: aragonite type crystal (λ-carbonate), calcite type crystal (β-carbonate) and vaterite type crystal (μ-carbonate), in the $BaCO_3$-$SrCO_3$-$CaCO_3$ system. The phase domains of these three crystal forms are affected somewhat by the temperature at which the precipitation is carried out. The triple diagrams are obtained at two stages of precipitation temperature. A.

548.74

4488. Electron diffraction study of the hydrogen bonds in boric acid. J. M. COWLEY. Letter in *Nature* [*London*], **171,** 440–1 (*March* 7, 1953).

Canonical arrangements of hydrogen ions in hydrogen bonds between the oxygen atoms of boric acid are proposed to explain the observed electron diffraction pattern. G. I. W. LLEWELYN

548.74

4489. A new type of striation observed in electron-micrographs of sericite. Y. SEKI. *J. Phys. Soc. Japan*, **8,** 149–51 (*March–April*, 1953).

A series of striae equally spaced was observed in a region of an electron-micrograph where two thin rectangular crystal flakes of sericite, a clay mineral, overlapped each other in almost parallel orientation, but with a small rotational angle around their common axis. An interpretation of this striation by the hypothesis of double diffraction of electrons caused by rotational overlapping of two crystal flakes was carried out. The possible spacing of the net plane responsible for this diffraction was calculated from the separation of the striation and the small rotational angle of the two flakes. The result did not contradict that from the electron diffraction photograph of a single flake obtained by a three-stage electron microscope. A.

GEOPHYSICS 55

550.311 : 532.5 : 536.25

The onset of convection by thermal instability in spherical shells. *See Abstr.* 4053

550.341

4490. The magnetic tape recorder in near tremor recording. H. DÖRMANN. *Ann. Géophys.*, **8,** 286–93 (*July–Sept.*, 1952) *In German.*

It is shown that it pays to use, for this purpose, seismographs with higher limiting frequencies than those used so far. The running cost may be kept low

by the intermediate use of magnetic-tape recorders. An instrument of this type is described, and first results are discussed. A.

550.342

4491. Studies of a surface seismic disturbance. J. D. EISLER. *Geophysics*, **17**, 550–61 (*July*, 1952).

Seismic studies in a caliche covered area revealed existence of a prominent surface wave group. The dispersive characteristics of this wave group and the existence of retrograde elliptical particle motion place it in a class of Rayleigh waves. Examples of vertical as well as two-component motion are presented. A.

550.381 : 538.082

4492. Magnetic measurements in deep-sea investigations. *Nature* [*London*] **171**, 383–5 (*Feb.* 28, 1953).

Construction of non-magnetic containers. N. ARLEY, B. LUNN, M. NIELSEN AND C. NØRGAARD (383–4).

Describes 2 non-magnetic containers made to house recording magnetometers for making measurements down to depths of 10 000 m. One container is spherical with internal dia. 50 cm; the other consists of 2 similar spheres joined by a tube 100 cm long. They are constructed of a new alloy which is an iron-free β-manganese bronze with high aluminium content.

Magnetic investigations on the Galathea expedition. N. ARLEY, P. ANDREASEN, J. ESPERSEN AND J. OLSEN (384–5).

Describes 3 self-recording magnetometers for measuring H and Z, two of the La Cour type and one self-inductor. Working methods of using these, housed in the above containers, were developed during the expedition. It was found possible to determine in about 1 hr the value of H to within 5γ at depths down to 4000 m. Important perturbation effects of the ocean floor, when rugged, were found. H and Z were found to increase numerically with increasing depth below the sea level. A. T. PRICE

550.385

4493. Semi-local, unstable manifestations of terrestrial magnetism. E. SELZER. *Ann. Géophys.*, **8**, 275–85 (*July–Sept.*, 1952) *In French.*

The magnetic storm of Sept. 30 to Oct. 7, 1950, showed individual disturbances during successive days having the shape of sharp, big oscillations, which had not been clearly observed before. An attempt is made to define these features and the semi-local factors which seem to control the phenomenon. Possible relations with similar semi-local features of a certain kind of ionospheric storminess are suggested. A.

550.385 : 523.755

4494. The corona and geomagnetism. M. J. SMYTH. *Observatory*, **72**, 236–9 (*Dec.*, 1952).

Possible time-relationships between geomagnetic activity and the occurrence of bright "*C*-regions" of the inner corona, observed in monochromatic light ($\lambda\lambda$5303 and 6374), are studied, especially in relation to the eight magnetic storms of the 1950 *M*-sequence beginning July 11. These storms were not heralded by bright east-limb inner corona, in fact the intensity of λ5303 shows a minimum about 8 days preceding the onset of the storms. Moreover, the magnetic activity shows a minimum about 3 days after the CMP of bright λ5303. This is in contrast with von Klüber's observation that the CMP of a "white" coronal streamer precedes by about a day the onset of a storm. A. T. PRICE

550.385 : 551.594.5

Doppler displacement of auroral hydrogen lines and its bearing on the theory of aurora and magnetic disturbances. *See Abstr.* 4518

ATMOSPHERE . METEOROLOGY 551.5

551.501.45 : 519.2

4495. Handbook of statistical methods in meteorology. C. E. P. BROOKS AND N. CARRUTHERS. *London: Her Majesty's Stationery Office* (1953) viii + 412 *pp.*

The opening chapters show how to make the best use of meteorological observations, for instance, by means of graphs, averages and frequency diagrams. Part II describes the comparison of series by correlation, the fitting of curves and other problems involving two or more related variables. Part III deals with the sequence of weather—"persistence"—from one day or month to the next and the study of weather "cycles," including new interpretations of the results. The book is eminently practical; long mathematical arguments are avoided and working instructions are given for making each calculation with the least labour. The examples are drawn almost exclusively from meteorology, but the methods should find wide application in other subjects.

551.508.765

4496. A cloud-droplet sampler for use on aircraft. P. SQUIRES AND C. A. GILLESPIE. *Quart. J. Roy. Meteorol. Soc.*, **78**, 387–93 (*July*, 1952).

An instrument is described with which cloud-drop let samples can be taken from an aircraft by exposing momentarily glass rods coated with magnesium oxide. Exposures can be repeated about every three seconds (i.e. about every 200 m). The spectra found in a traverse through a cumulus are shown. Features of the distribution of spectra can be determined which could not readily be found by methods which average over some distance, or by sampling methods not capable of being repeated so often. The samples are too widely spaced, however, to yield a coherent sequence of spectra across a cumulus. A

551.510.4

4497. Identification of carbon monoxide in the atmosphere above Flagstaff, Arizona. A. ADEL Note in *Astrophys. J.*, **116**, 442–3 (*Sept.*, 1952).

551.510.53

4498. The development of ionospheric layers through temperature variations in the atmosphere. G. BURKARD. *Geofis. pura appl.*, **22**, 63–74 (*Jan.–March* 1952) *In German.*

The production of ions by monochromatic radiation in an atmosphere having different temperature at different heights is considered. Under certain conditions of temperature variation the *F*-layer can split into F_1- and F_2-layers; but it is shown that the F_2-layer is always colder than the F_1-layer.

551.510.535

4499. A study of ionospheric winds and turbulence utilizing long radio waves. G. H. MILLMAN. *Ann. Géophys.*, **8**, 423–42 (*Oct.–Dec.*, 1952).

This work is mainly concerned with the study and experimental determination of wind movements in the *E*-layer of the ionosphere by radio pulse techniques at a frequency of 150 kc/s and the statistical analysis of the fading of vertically incident pulsed 150 kc/s radio waves. Evidence is presented which indicates the presence of diurnal and seasonal variations of upper atmospheric wind movements. Data obtained during the period from July, 1951, through March, 1952, are statistically analysed and compared with theoretical postulates. A.

551.510.535 : 538.566.3

Radio-wave propagation in the ionosphere. *See Abstr.* 4233–4

551.511 : 551.551

4500. The dissipation of kinetic energy in the lowest layers of the atmosphere. R. J. TAYLOR. *Quart. J. Roy. Meteorol. Soc.*, **78**, 179–85 (*April*, 1952).

The supply of kinetic energy to a shallow layer of air is considered. The cases chosen for analysis comprise occasions of comparatively strong wind and of fairly small temperature gradient so that the supply of kinetic energy from the vertical flux of total heat is not important at small heights. In these cases the diffusive flux of kinetic energy is also shown to be negligible. Hence it follows that, on these occasions, the rate of dissipation per unit volume is given by the product of the local values of the shearing stress and vertical gradient of mean velocity when steadiness and horizontal uniformity of the turbulence are assumed. Estimates of the rate of dissipation per unit mass at heights from 1 m to 50 m are made for particular occasions and used, together with the observed energy densities, to provide estimates of the size of the dissipating eddies at the heights of observation according to expressions given by L. F. Richardson (1920) and G. I. Taylor (1935). A.

551.574.1 : 551.508.91

4501. A condensation nuclei counter with photographic recording. L. W. POLLAK. *Geofis. pura appl.*, **22**, 75–83 (*Jan.–March*, 1952).

551.574.1 : 551.576.1 : 551.501.8

4502. Theory of the radar upper band. R. WEXLER. *Quart. J. Roy. Meteorol. Soc.*, **78**, 372–6 (*July*, 1952).

It is shown how the growth of a layer of graupel and the subsequent depletion of the cloud liquid-water content below a critical value is capable of explaining the observations pertaining to the radar upper band, described by Bowen [Abstr. 3985 (1951)]. A.

551.574.1 : 551.577.11 : 551.501.81

4503. Precipitation growth in stratiform clouds. R. WEXLER. *Quart. J. Roy. Meteorol. Soc.*, **78**, 363–71 (*July*, 1952).

The radar observations along the vertical of precipitation in stratiform clouds are compared with the theoretical growth rates of ice crystals in such clouds. The analysis indicates that no liquid water exists in these clouds at levels above about −5°C. The variation of signal strength from the −3°C level through the "bright band" and the drop-size distribution in the rain measured at the ground can be satisfied by reasonable assumptions concerning the coalescence of ice crystals. A.

551.574.1 : 551.578.11

4504. Production of rain and drizzle by coalescence in stratiform clouds. B. J. MASON. *Quart. J. Roy. Meteorol. Soc.*, **78**, 377–86 (*July*, 1952).

Calculations have been made of the rate at which droplets originating on salt nuclei of given mass grow by both condensation and coalescence with smaller droplets in layer clouds of given uniform updraught, mean temperature, supersaturation and liquid-water content; also of the rate at which the drops falling from the cloud will shrink by evaporation before reaching the ground. It is shown that clouds sustained by uniform updraughts of up to 10 cm sec^{-1} with no turbulent motion would be incapable of producing drizzle at the ground unless their liquid-water contents were considerably higher than measured values indicate. It is suggested that turbulence plays an important part in releasing precipitation from non-freezing layer clouds by increasing the effective fall path of some larger droplets among their small neighbours; this would lead to increased growth by coalescence. In order to start the coalescence process, a few droplets considerably larger than average must be present. It does not appear possible to account for this initial heterogeneity in the droplet-size spectrum otherwise than by assuming that these larger droplets grow by condensation for a considerably longer period than the rest. It is suggested that while the bulk of the cloud droplets have their growth periods limited by the fact that they are continually being transferred by eddies between the interior and the boundaries of the cloud, a few remain in the interior for a long time, and it is these which initiate coalescence. These would have to exist in the cloud for 3 to 4 hr before falling out as drizzle drops. A.

551.578.11 : 551.501.8

4505. Radar observations of rain from non-freezing clouds. R. S. STYLES AND F. W. CAMPBELL. *Austral. J. Phys.*, **6**, 73–85 (*March*, 1953).

It is now conceded that drizzle or light rain may fall from clouds which do not reach freezing level, but it is still not generally accepted that heavy precipitation is also possible from such clouds. This paper adds five further airborne radar observations of non-freezing rain (in the vicinity of Sydney, Australia; latitude 35°S) to the relatively few accounts of moderate to heavy precipitation already recorded as falling from such clouds. Observations described are of rain, which at its peak reached "very excessive" proportions at ground level, falling from clouds, 9000–10 000 ft deep, which had developed in a maritime air mass either over sea or slightly inland. The shape of the radar echo observed from the rain in these clouds was that of a vertical column. The radar echo reached its maximum development at or just prior to the time of maximum development of the cloud, following which both the cloud and the radar echo immediately commenced to subside or dissipate. Maximum precipitation rate at ground level generally occurred after the cloud had passed its maximum development. While the storm was

developing the radar echo was generally characterized by a maximum in the middle levels of the cloud, but during the decay stage the radar echo became more uniform with height. These observations support the theory that the mechanism of rain formation at work in such clouds is that of coalescence of water drops. A.

551.578.11 : 551.573

4506. The evaporation of raindrops. A. C. Best. *Quart. J. Roy. Meteorol. Soc.*, **78**, 200–25 (*April*, 1952).

The evaporation of a single drop of water as it falls through an atmosphere in which the lapse rate is 6·5°c/km and the surface temperature either 15°c or 41°c is examined. By making certain justified assumptions, it is shown that the change in surface area of a large drop (i.e. with radius >0·15 mm) as it falls from height z_1 to z_2 is proportional to $(1-f)^{1\cdot13}\exp(-lz)$ where $100f$ is the relative humidity and l is a constant. Values are given for the constant of proportionality and for l. If the drop has a radius <0·15 mm the change in volume of the drop is proportional to $(1-f)^{1\cdot062}\exp(-lz)$. These results are then used to assess the effect of evaporation on the size and size distribution of raindrops falling through a constant atmosphere. It is shown that if the size distribution of raindrops at some initial height is given by $1-F=\exp[-(2a/b)^n]$ where F is the fraction of liquid water comprised by drops with radius $<a$, and b and n are constants, then evaporation will lead to a change in the values of b and n but will not affect the general validity of the formula. As the rain falls through the non-saturated air the distributive index n tends to a value between 3·5 and 4·0 whether it was greater or less than such a value initially. If the initial value of $n<3\cdot0$ the scale diameter b increases as a result of evaporation. If the initial value of $n>$ about 3·5 the scale diameter decreases. The effect of evaporation upon the radar response from falling rain is also examined. In the last section the effect of the evaporation of rain into air which is initially unsaturated is considered. It is shown that the air temperature tends to a steady value and the relative humidity to 100%. The excess of temperature above the steady-state value and the deficit of relative humidity below 100% decrease exponentially to zero with time. The depression of the steady-state temperature below the initial temperature is a function only of the initial temperature and relative humidity and a table is given showing the value of the steady-state temperature for 9 different sets of initial conditions. The rate at which the final state is approached depends, however, only upon the rate of rainfall and a formula is derived for this dependence. A.

551.591

4507. Selective annotated bibliography on visibility. N. T. Zikeev. *Meteorol. Abstr.*, **3**, 942–85 (*Sept.*, 1952).

281 items, mainly of the period 1930–1952, but containing a few items back to 1788. Each item has a short abstract. Subject index.

551.593

4508. Unusual aerial phenomena. J. A. Hynek. *J. Opt. Soc. Amer.*, **43**, 311–14 (*April*, 1953).

Over a period of years, diverse aerial sightings of an unusual character have been reported. On the assumption that the majority of these reports, often made in concert, come from reputable persons, and in the absence of any universal hypotheses for the phenomena which stimulated these reports, it becomes a matter of scientific obligation and responsibility to examine the reported phenomena seriously, despite their seemingly fanciful character. Accordingly, several hundred serious reports of "unidentified aerial objects" have been studied in detail in an attempt to get a pattern classification. It appears that those reported phenomena which do not admit of a ready and obvious explanation exhibit fairly well-defined patterns and that these are worthy of further study. One pattern in particular, that of a hovering nocturnal light, does not appear to be readily explainable on an astronomical basis or by mirages, balloons or by conventional aircraft. A.

551.593

4509. Phantasmagoria or unusual observations in the atmosphere. U. Liddel. *J. Opt. Soc. Amer.*, **43**, 314–17 (*April*, 1953).

For many eras in man's history, the sky has been occupied by various gods, or constellations, or birds, mythical or real. A new concept has arisen in the last few years, largely a product of aviation and balloonry, and civil air defence spotters. In general the reports have more psychological than physical significance. However, certain optical phenomena are now gaining far wider interest than among research men in optics. Some "authentic reports" by "reliable, competent observers" are recounted and considered. While complete interpretation of all "reports" is impossible, due to lack of sufficient experimental data, no evidence exists for any phenomena not explicable by standard physical concepts. A.

551.593.5 : 551.521.3

4510. A statistical model for water-vapour absorption. R. M. Goody. *Quart. J. Roy. Meteorol. Soc.*, **78**, 165–9 (*April*, 1952).

A statistical model of a water-vapour absorption band is discussed, and comparison with computations made by Cowling shows that it provides a very accurate account of the average transmission over narrow frequency bands. The model can be used to compute the atmospheric transmission by water vapour under conditions of meteorological importance which were not treated by Cowling. A.

551.593.5 : 551.521.3

4511. Transfer theory for purely pressure-broadened band spectra. J. I. King. *Astrophys. J.*, **116**, 491–(*Nov.*, 1952).

A complete analysis is given for the following model of atmospheric transmission: The atmosphere is in local thermodynamic equilibrium without scattering; the half-width of any line is proportional to the total pressure prevailing at any level. In view of the application to transfer in the far infrared bands of the earth's atmosphere, an idealized molecular band consisting of a series of equal and equidistant lines is assumed. It is possible to express the radiative cooling rates and the conditions of radiative equilibrium for this model in terms of integrals containing only elementary functions under the integral sign. For intense lines the formalism becomes greatly simplified. A

551.593.9

4512. Photometry of the u.v. region of the light of the night sky. D. BARBIER. *C.R. Acad. Sci.* [*Paris*] **236,** 276–7 (*Jan.* 19, 1953) *In French.*

An auto-recording photoelectric photometer was used at the observatory of Haute-Provence on 46 nights, Sept., 1951–Aug., 1952, to study the Herzberg O_2 bands in the u.v. spectrum of the night sky. Diurnal, seasonal and irregular fluctuations of intensity are found which appear similar to those associated with the O I emission at 5577 Å. The major part of the u.v. radiation originates at 200 ± 50 km and its total intensity corresponds to $1{\cdot}5\times10^8$ transitions $sec^{-1}\,cm^{-2}$ vertical cross-section of atmosphere. D. R. BARBER

551.593.9 : 537.591

4513. Light pulses from the night sky associated with cosmic rays. W. GALBRAITH AND J. V. JELLEY. Letter in *Nature* [*London*] **171,** 349–50 (*Feb.* 21, 1953).

On 3 occasions in 1952 short-period (~0·2 μsec) pulses of night-sky light have been recorded with a photo-multiplier, and observed to be strongly correlated with bursts of cosmic rays. The observations appear to support Blackett's prediction (1948) that $\sim10^{-4}$ of the total n-s radiation may be expected to originate from Cherenkov radiation produced by cosmic rays, although the results to date give no direct evidence that the observed light pulses result from this particular radiation. D. R. BARBER

551.594.11

4514. Changes of atmospheric electric potential gradient at Poona during disturbed weather. M. V. SIVARAMAKRISHNAN. *Indian J. Meteorol. Geophys.*, **4,** 62–75 (*Jan.*, 1953).

A detailed study for the years 1936–40 has been made. From the analysis it is seen that if during rainfall the potential gradient is negative but without rapid variations the rainfall is associated with a quiet atmosphere, whereas large and rapid changes in the potential gradient are usually associated with atmospheric disturbances having appreciable local ascending air currents such as rainfall occurring in shadows. Changes in potential gradient are not closely associated with either the intensity or the variations of the rainfall. The field at the ground is not essentially different in thunderstorms from that associated with showers. Two main types of potential gradient patterns have been recognized: (*a*) wave patterns, (*b*) symmetrical patterns. Some of the patterns are seen to be associated with definite types of weather. A.

551.594.11 : 551.508.94

4515. New apparatus for recording the atmospheric electric field. L. ACCARDI. *Geofis. pura appl.*, **22,** 84–8 (*Jan.–March*, 1952) *In Italian.*

551.594.12

4516. A new method of measuring the electrical space charge density of the air. R. MÜHLEISEN AND W. HOLL. *Geofis. pura appl.*, **22,** 189–94 (*April–June*, 1952) *In German.*

A waterdrop, falling from an earthed injection-needle within an earthed screening-cage is influenced by the electric space charge of the surrounding air. The drop therefore leaves the point with a true electric charge proportional to the space charge of the air. A method for measuring electric charge on water drops is described. Recording of the space charge is possible to a sensitivity of about ±10 electronic charges/cm³. Volta potentials cause a zero uncertainty of ±25 electronic-charges/cm³. Three measurements can be made in a second. A.

551.594.21 : 537.591.1

High-energy particles from thunderstorms. *See Abstr.* 4184

551.594.5

4517. The auroral spectrum in the wavelength range 3300–8900 Å. W. PETRIE AND R. SMALL. *Astrophys. J.*, **116,** 433–4 (*Sept.*, 1952).

Some 150 spectra of the aurora have been secured with a grating instrument which produces a linear dispersion of 85 Å/mm in the first-order spectrum. The first 3 orders of the grating have been used in obtaining these spectra. Tables have been prepared listing those features whose origin is certain, and these data will provide useful information for a study of the excitation of the aurora. Remarks are made about any apparent anomalies in the spectra. A.

551.594.5 : 550.385

4518. Doppler displacement of auroral hydrogen lines and its bearing on the theory of aurora and magnetic disturbances. L. VEGARD. *Geofys. Publ.*, **18,** *No.* 5, 14 *pp.* (1952).

A detailed review of the author's observations of displaced Balmer lines in auroral spectra in relation to his proton-electron theory of the solar corpuscular stream as a cause of auroral and geomagnetic disturbances. In particular, it is shown as a consequence of the differing velocities of the two components of an electrostatically-neutral stream that the rel. intensity of the H-lines in an auroral spectrum should pass through a max. with decreasing altitude of emission, since protons will be absorbed at higher atmospheric levels than will electrons. Also, since intensity of H-lines will vary with proton velocity, the intensity observed in the spectrum should increase with magnetic polar distance. Both inferences are confirmed by observation. As a further consequence of $v_{proton} < v_{electron}$, it is shown that the original theories of Birkeland and Stormer are valid, and may therefore be used to explain the typical features of aurorae and magnetic storms. D. R. BARBER

551.594.52 : 551.501.8 : 621.396.9

4519. Localization of aurorae with 10 m high power radar technique, using a rotating antenna. G. HELLGREN AND J. MEOS. *Tellus*, **4,** 249–61 (*Aug.*, 1952).

The paper describes the 10 m high-power recorder with rotating aerial used since May, 1951, for the localization of aurorae at the Radio Wave Propagation Laboratory of the Kiruna Geophysical Observatory (67·8°E, 20·5°N). Continuous observations during the time May, 1951–March, 1952 have disclosed periods of auroral activity. The preliminary results from these observations indicate that there is a good correlation between the auroral activity, the magnetic activity and the appearance of the *N*1-layer, a special type of sporadic *E* ionization often appearing in connection with magnetic bays and supposed to be caused by the same ionizing agent as the aurora. The distribution in range and bearing of the recorded aurorae agrees with the simple theory that most of

the radio wave scattering comes from those points where the radar beam is perpendicular to the surface of the auroral discharges. The calculated height distributions of the reflection centres have maxima around 120 km. A.

551.594.7 : 518.3 : 621.3.012.3 : 621.396.11

4520. Nomograms for the computation of tropospheric refractive index. D. M. SWINGLE. *Proc. Inst. Radio Engrs*, **41**, 385–91 (*March*, 1953).

Three sets of nomograms permitting calculation of tropospheric refractive index, refractive index discontinuity and vertical refractive index gradient are presented. So far as is known, no similar charts have been made for discontinuity and gradient calculations. All three have been designed about the standard radiosonde transmission, which gives temperature, dew-point temperature and pressure at points where discontinuities occur in the vertical gradients of temperature or dew-point temperature. These nomograms are valid for all wavelengths $>1 \cdot 5$ cm. A.

BIOLOGY 57/59

578.088.2 : 534.23

4521. The use of high intensity ultrasound in experimental neurology. P. D. WALL, D. TUCKER, F. J. FRY AND W. H. MOSBERG, JR. *J. Acoust. Soc. Amer.*, **25**, 281–5 (*March*, 1953).

A histological study of the changes produced in tissue of the central nervous system. The study was restricted to the non-temperature effects of the sound since these are of particular significance for neurology. The results obtained show that nerve cell bodies are particularly sensitive to the action of the ultrasound, while blood vessels and nerve fibres are much more resistant. The use of a focused beam of ultrasound to produce discrete lesions deep in the brain without disturbance of the vascular system or through-going nerve tracts in the region of the lesion is demonstrated by a study on the bulboreticular inhibitor formation of the cat medulla. Physical factors which require consideration are discussed in terms of the histological work. A.

578.088.2 : 534.23

4522. Effects of sonic vibration on the proteolytic activity of pepsin. G. M. NAIMARK AND W. A. MOSHER. *J. Acoust Soc. Amer.*, **25**, 289–90 (*March*, 1953).

Pepsin preparations were sonically treated for various periods of time in a 9 kc/s magnetostriction oscillator with the temperature maintained at 13°C–16°C during treatment. After sonic treatment the residual proteolytic activity of the enzyme was determined by measuring the turbidity decrease during the digestion of an albumin substrate. It was found that dilute solutions of Merck U.S.P. pepsin were rapidly inactivated by sonic treatment whereas highly concentrated solutions were refractory to ultrasonic destruction. Sonic irradiation of a pure Armour crystalline pepsin solution yielded slight enzyme inactivation only. In no instance was enzyme activation observed in this study. A.

578.088.2 : 612.014.481.1

4523. The limits of the target theory of the biological action of radiation. B. RAJEWSKY. *Brit. J. Radiol.*, **25**, 550–2 (*Oct.*, 1952).

Some experiments on the irradiation of Arabidopsis seed and of digitalis pollen by X-rays generated at 180 kV dose-rate 2700 r/min to total doses about 600 000 r. To determine the effects of diffusion processes the irradiations were carried out at normal temperatures and at the temperature of liquid air. Results indicate approximately 80% of radiation effects are temperature-dependent since at low temperatures the effectiveness of a given dose is reduced to ~20%. T. A. CHALMERS

MEDICAL SCIENCE . HUMAN PHYSIOLOGY 63

612.014.462.481 : 539.172.3

4524. Energy absorption in human tissue by nuclear processes with high-energy X-rays. R. J. HORSLEY, H. E. JOHNS AND R. N. H. HASLAM. *Nucleonics*, **11**, 28–31 (*Feb.*, 1953).

An estimate is made of the total energy absorbed in wet tissue as a result of photo-nuclear processes produced by high-energy betatron bremsstrahlung. The reactions considered are the (γ, n), (γ, p) and (γ, α) reactions in C^{12}, N^{14} and O^{16}. It is shown that, in the case of 24 MeV bremsstrahlung, only $0 \cdot 3\%$ of the total ionization in the tissue results from these reactions. About double this effect is produced by betatron radiation in the range of 30–50 MeV, but above this region the contribution of the nuclear reactions decreases. L. R. SHEPHERD

612.2 : 626.0

4525. Physics and physiology in diving decompression. H. SCHENCK, JR. *Amer. J. Phys.*, **21**, 277–8 (*April*, 1953).

The fundamental problem of not exceeding the critical saturation of N in a diver's body requires both physics and physiology in its solution. The basic differential equations of N saturation and desaturation in a specific tissue are integrated over an idealized dive. Constants determined through physiological research can be substituted and a time-depth ascent curve for any tissue established. A step-wise method is outlined whereby critical tissues in each portion of the ascent can fix the proper ascent curve for the entire body. The advantage of pure O breathing is demonstrated numerically and the failure of He–O mixtures to shorten ascents is explained by use of the derived equations.

612.841 : 535.3

Optical method of studying the shape of a reflecting surface. *See Abstr.* 3965

612.843.2

4526. The effect on foveal vision produced by a spot of light on the sclera near the margin of the retina. G. A. FRY AND M. ALPERN. *J. Opt. Soc. Amer.*, **43**, 187–8 (*March*, 1953).

Two points on the sclera, one in front of and one behind the ora serrata, have been alternately illuminated and the flux densities in the two spots were adjusted until the visual field lit up by the light diffusely transmitted through the sclera maintained a constant brightness as a switch was made from one spot to the other. There was no difference in switching from the first to the second as compared to switching from the second to the first. Schouten and Ornstein, who had previously performed a similar experiment, found a difference in the two types of alternation, and used their finding as evidence of transmission of an effect through the retina from the ora serrata to the fovea. The present findings support the opposite hypothesis—namely, that the effect is mediated by stray light. A.

612.843.2

4527. The effect of a peripheral glare source upon the apparent brightness of an object. G. A. FRY AND M. ALPERN. *J. Opt. Soc. Amer.*, **43**, 189–95 (*March*, 1953).

The decrease in perceived brightness of a foveal test object produced by a peripheral glare source can be accounted for in terms of a veiling luminance produced by stray light falling on the fovea. The same effect can be produced by an artificial patch of veiling luminance superimposed on the test object. The effect of increasing the angle between the glare source and the test object is equivalent to reducing the brightness of the glare source in accordance with the stray light hypothesis. The measured amount of veiling luminance conforms to that found by previous investigators. The changes in brightness that occur immediately following the onset of a peripheral glare source as well as the changes which occur following removal of the glare source can all be accounted for in terms of the veiling luminance produced by stray light falling on the fovea. A.

612.843.31

4528. Retinal receptors isolated with a.c. method and polychromatic theory. K. MOTOKAWA AND M. EBE. *J. Opt. Soc. Amer.*, **43**, 203–9 (*March*, 1953).

Threshold voltages of alternating currents passing through the head as determined with flickering phosphenes as an index were plotted as a function of frequencies, and 7 conspicuous minima were found in the curve. It was shown that these minima are the result of differential sensitivity of 7 types of receptor having their own time-constants. Based on the fact that the electrical sensitivity of the eye as measured by an a.c. of any optimal frequency is selectively enhanced on exposure of the retina to weak spectral lights of wavelengths of a certain limited range, a spectral response curve was determined for each kind of receptor. The response curves determined in this way had such sharp peaks, well localized on definite parts of the spectrum, that the optimal wavelength for each kind of receptor could be determined with sufficient accuracy. The optimal wavelengths and resonance frequencies of the receptors are as follows: red (650 mμ) 77 cycles per sec; orange (610 mμ) 62·5 c/s; yellow (575 mμ) 52·5 c/s; green (515 mμ) 42·5 c/s; blue (465 mμ) 35 c/s; violet (415 mμ) 28·5 c/s; rod or scotopic receptor (507 mμ) 20 c/s. A.

612.843.611

4529. Effect of glare and course re-adaptation. O. F. RANKE. *Licht-technik*, **4**, 64–6 (*March*, 1952) *In German.*

A general treatment of glare and adaptation with special reference to the course of re-adaptation immediately after the momentary exposure of the dark-adapted eye to a high value of illumination.

J. W. T. WALSH

612.843.613

4530. Visual thresholds for line-shaped targets. M. A. BOUMAN. *J. Opt. Soc. Amer.*, **43**, 209–11 (*March*, 1953).

Measurements of absolute and contrast thresholds values 7° nasal from the fovea for 6500 and 5250 Å for line-shaped targets 2′ in width, length l between 2′–256′ and time of observation t between 0·02–1 sec are presented. The absolute thresholds agree with what was to be expected from the two-quanta theory. For $l > 32'$ for green flashes and for $l > 8'$ for red ones, $\overline{N}_{60\text{ per cent}} \sim l^{\frac{1}{2}}$ and for $t > 0{\cdot}1$ sec, $\overline{N}_{60\text{ per cent}} \sim t^{\frac{1}{2}}$. When $t < 0{\cdot}1$ sec or $l < 32'$ for green and $l < 8'$ for red light, Bunsen–Roscoe's and Ricco's law, respectively, is valid. Also, predictions for the behaviour of the contrast thresholds for line-shaped sources are made which are also based on the quanta theories for these visual functions. The dependence of the contrast threshold $\langle \Delta \overline{N}_{60\text{ per cent}} \rangle_{Av}$ on l for large l for line-shaped targets is equal to the dependence of $\langle \Delta \overline{N}_{60\text{ per cent}} \rangle_{Av}$ on t and corresponds with the dependence of $\langle \Delta \overline{N}_{60\text{ per cent}} \rangle_{Av}$ on t and on the diameter d of circular flashes in the way predicted by theory. A.

612.843.63

4531. Luminance thresholds for the resolution of visual detail during dark adaptation. J. L. BROWN, C. H. GRAHAM, H. LEIBOWITZ AND H. B. RANKEN. *J. Opt. Soc. Amer.*, **43**, 197–202 (*March*, 1953).

Luminance thresholds for the visual resolution of various widths of alternating light and dark lines were determined at various times during dark adaptation. The finest gratings, representing high degrees of visual acuity, show only a single cone curve that drops from a high luminance threshold during the first moments of dark adaptation to a final steady level that is reached after about 7 to 10 min in the dark. Coarse gratings produce a duplex curve that shows an initial cone portion and a delayed rod portion. Visual acuity is a parameter that sets the position of a given curve on the log threshold axis. The higher the degree of resolution required, the higher the dark adaptation threshold. At a constant grating luminance, visual acuity rises rapidly to a maximum during dark adaptation; the higher the luminance, the earlier and more rapid the rise and the higher the maximum. Visual acuity increases at all dark adaptation times with increase in luminance. A.

612.843.631

4532. The absorption of red light by dyes and its occurrence in vision. J. SÉGAL. *Rev. Opt.*, **31**, 433–44 (*Oct.*, 1952) *In French.*

The great majority of dyes show, in the far red of the spectrum, a sharp fall in the absorption coefficient, followed by an almost horizontal region. The very rare exceptions to this rule owe their peculiarity to the presence of metallic ions having their own absorbing power. The drop in absorption at 6800 Å is less obvious, the more strongly the dye is dissociated. For a suspension of microcrystals which represent a state of complete ionization, this drop followed by a level region is replaced by uniform gradient. The observed phenomena can be considered as the equivalent of the forbidden zone in the emission of dielectrics. The spectral sensitivity curve of the human eye shows no irregularity in the region of 6800 Å. The absorbing pigment which determines the sensitivity of the eye to long wavelengths cannot therefore be present in the dissolved state. A crystalline pigment, on the contrary, as is found in the fringes of pigment epithelium, would have the required physical properties. A.

612.85

4533. Effect of different types of electrodes in electrophonic hearing. G. FLOTTORP. *J. Acoust. Soc. Amer.*, **25**, 236–45 (*March*, 1953).

Depending upon the kind of electrode system employed, a sinusoidal electric current gives rise to at least five phenomena. (1) With a moving electrode on the skin or on the roof of the mouth (fricative effect), the subject receives the strongest sensation of hearing. He may hear either the first harmonic or the first and second harmonics, or the second harmonic alone, depending upon the applied voltage and upon the placement and properties of the electrode. (2) With a large-area electrode any place on the skin of the head, if the skin is dry the subject hears the second harmonic; if it is wet, he hears nothing. (3) When the electrode is immersed in salt solution in the ear (the most common method), the subject hears a complex tone containing mostly second harmonic, suggesting the action of a square-law transducer. (4) When the electrode is on the mucous tissue inside the middle ear (with eardrum removed), the subject hears the first harmonic and/or a noise. (5) When the electrode is in contact with the epidermis of the meatus, the subject hears the first harmonic, and at low frequencies he may also hear a noise. The experimental results seem to indicate that the hearing of a tone under any of these five conditions is probably due to vibrations set up outside the cochlea, although there appear to be at least four different transducing mechanisms. Contrary to earlier hypotheses, the tympanic membrane is apparently not involved in the conversion of the electrical energy into mechanical vibration. A.

614.898

4534. A study of the X-irradiation protection afforded by cobalt. W. PARR, T. O'NEILL AND A. KREBS. *Science*, **117**, 155–8 (*Feb.* 13, 1953).

The mortality rate of mice receiving whole-body irradiation (720 r with 200 kV X-rays) is compared for groups having a normal diet, and groups to whose diet $CoCl_2$ has been added. Mortality for the latter is reduced by a half. The protection seems to be due to the polycythemia-producing effect of the cobalt. Possible mechanisms are discussed briefly and some references given. D. V. MABB

614.89

4535. Protection from the effects of radiation *Nature* [*London*] **171**, 378–9 (*Feb.* 28, 1953).

Brief summaries (100 words or less) are given o papers read at a joint meeting of the Institute o Physics (Industrial Radiology Group) and th Hospital Physicists' Association, held in January 1953, at the Royal Institution. Subjects covere were: the beginnings and growth of X-ray protectio by means of film badges, now undertaken on a larg scale by the N.P.L.; the delayed action of the bio logical effects of radiation; the latest methods c dosage measurement by means of films; monitc ionization chambers used at Harwell; the danger i radioactive substances now being used by previousl inexperienced firms (few accidents with radioactiv substances are, however, reported though exhaustiv regulations are not enforced; doses to industri personnel average well below the "tolerance" level No references are given, nor any indications of full publication elsewhere. D. V. MABB

615.8

4536. Shaped sources for teletherapy units. M BRUCER, W. G. POLLARD, H. LEITER AND H. SCAR *Nucleonics*, **11**, 38–41 (*Feb.*, 1953).

The emission of γ-radiation from large sources examined to find the effect of increasing the rat of surface area to volume, on the efficiency of emissio It is concluded that a right cylindrical source with t base as presenting face is the most efficient unit. L. R. SHEPHEE

615.849 : 51

4537. An automatic tissue dose computer for use supervoltage rotational therapy. W. S. MOOS AN E. W. WEBSTER. *Radiology*, **59**, 729–36 (*Nov.*, 195

A simple electrical computer is described whi enables an estimate to be made of the dose receiv at any point in an irradiated body section during o rotation cycle. The dose is expressed in terms of t air dose at the centre of rotation. The simplifyi assumptions used in the computation are shown produce small errors for conditions obtaining therapy with 2 MeV X-rays. H. MILL

616–073.75 : 537.5

4538. An automatic method of studying the distri tion of activity in a source of ionizing radiation. W. MAYNEORD AND S. P. NEWBERY. *Brit. J. Radiol.*, 589–95 (*Nov.*, 1952).

A fuller, and up-to-date, account of work p viously described [Abstr. 1372 (1952)]. A simp scanning head has been evolved, using a sin Pb-cathode Geiger counter. Results of scannin model thyroid containing radio-iodine are sho A method of superimposing an optical image of part scanned has been devised, and the question radiation received at the counter from other parts a patient's body considered. Future possibilities outlined. D. V. MA

616–073.75 : 539.163

4539. The radiography of the human body with radioactive isotopes. W. V. MAYNEORD. *Brit. J. Radiol.*, **25**, 517–25 (*Oct.*, 1952).

Thulium (Tm^{170}) is a suitable radioactive isotope for human radiography, emitting mixed γ-radiation of 54 and 80 kV, and β-radiation of 1 MeV which is absorbed by embedding the source in a Perspex sphere of 1 cm diameter. Absorption of the radiation from this sphere is considered theoretically and experimentally (references and results given) and its use in radiography is demonstrated in a dry skull with the source at the centre of the buccal cavity or in the nasopharynx. Pictures of good definition and contrast are shown, and the advantages of an internal and portable source of radiation are noted, though present sources require exposures of 1 hr (with screens) at 12 cm source-film distance. Preliminary experiments indicate that even a low-intensity source could be used for location of foreign bodies, the source "scanning," and the radiation detected by a scintillation counter. D. V. MABBS

TECHNICAL MATERIALS 66/67

666.1.037.5

4540. Glass-to-metal seals making for laboratory purposes by a high-frequency method of heating. B. MAGLIĆ. *Receuil Trav. Inst. Rech. Struct. Matière [Belgrade]* **1**, 75–84 (*July*, 1952).

Three types of disk, three tubular and one cone seal of 99·5% pure electrolytic Cu with Pyrex glass are described. S. WEINTROUB

PHOTOGRAPHY 77

771.53

4541. Practical aspects of reciprocity-law failure. J. L. TUPPER. *J. Soc. Motion Picture Televis. Engrs*, **60**, 20–9 (*Jan.*, 1953).

The construction of D *v.* log E curves from reciprocity-law failure data is explained, and a description given of the effects due to varied exposure times, varied development times and a wide range of temperature during exposure. In the discussion, mention is made of work at exposures less than 1 μsec. S. T. HENDERSON

771.53 : 519.7

4542. Elementary probability of efficient absorption of a quantum proportional to the volume of a grain. L. SILBERSTEIN. *J. Franklin Inst.*, **255**, 51–8 (*Jan.*, 1953).

A mathematical investigation of the different results to be expected if the probability of absorption of quanta by Ag halide grains is proportional to the projected area of the grains, or, alternatively, to their volume. Assuming all the grains to have equal area and an exponential distribution of thickness, a marked difference is demonstrated between the curves of absorption probability *v.* fraction of the grains rendered developable by a given exposure. In the case of a Gaussian thickness distribution, a difference is also to be expected provided certain relations exist between the numerical constants. S. T. HENDERSON

771.531

4543. The form of the iso-opacity of a photographic layer. P. V. MEĬKLYAR. *Zh. eksper. teor. Fiz.*, **23**, *No.* 2 (8), 217–21 (1952) *In Russian.*

Iso-opacity is defined as the curve relating the logarithm of the quantity of illumination required for the production of a definite density of blackening, with the logarithm of the time of illumination. An equation is deduced for the iso-opacity of the photographic layer, on the basis of the assumption that a decrease in the light sensitivity of the photographic layer with an increase in the time of illumination is determined by the thermal destruction of the centres of the latent image in the early stages of their formation. It is shown that the maximum slope of the iso-opacity at long times of illumination is equal to 0·5. The activation energy of the thermal destruction of the Ag atom in the emulsion crystal is determined. The number of Ag atoms in the nucleus of the latent image is determined. A relationship is found between the number of atoms of Ag in the developing nucleus of the latent image and the time of development. E. RABKIN

771.534.5 : 539.27

A step wedge for sensitometry with the electron microscope. *See Abstr.* 4415

771.534.55

4544. Concerning photographic grain, signal-to-noise ratio and information. P. FELLGETT. *J. Opt. Soc. Amer.*, **43**, 271–82 (*April*, 1953).

The usefulness of applying such concepts as signal-to-noise ratio to the quantitative measurement of grainy photographic images has been limited by doubts as to how this ratio depended on the measuring apparatus, and, in particular, as to how it could be related to subjective measurements. Information theory now makes it possible to treat such subjective measures in terms of objective procedures which (in the sense that they extract all the relevant information content of the image) are ideal and cannot be bettered

by a human observer, but to which a skilled observer closely approximates. Examples are given illustrating how such procedures could be applied in photography. It is argued that the properties of grain can be described practically completely by the autocorrelation function of the transmission of the developed emulsion. An expression is derived giving, in terms of the autocorrelation function, the mean square fluctuation in transmission for any scanning aperture. This derivation makes no assumption as to the particular nature of grain. A rapid method of measuring the autocorrelation function is proposed. In terms of these concepts, some discussion is given of the "root area" law of granularity, parametric representation of grain and the relation of image sharpness to grain structure. A.

772 : 537.54

4545. A method of increasing photographic sensitivity by electrical discharges. K. S. LION. Letter in *J. appl. Phys.*, **24**, 367–8 (*March*, 1953).

A photographic film is fixed to one of the plates of a plane parallel counter and a voltage is applied. Incident radiation triggers a discharge pulse in the counter and under suitable conditions this gives rise to a well-defined picture point in the photographic emulsion. With a gas layer ~0·1 mm thick and 1100 V applied to the counter, an increase of photographic density of ~100 was obtained in an X-ray exposure, as compared with the picture taken without the applied voltage. S. T. HENDERSON

778.33

4546. Magnification of radiographic images in clinical roentgenology and its present-day limit. A. GILARDONI AND G. S. SCHWARZ. *Radiology*, **59**, 866–78 (*Dec.*, 1952).

Using an X-ray tube having a focal spot of size 0·3 mm, two methods of X-ray image-magnification are practicable: radiographic and photographic. The limits of useful magnification depend on the unsharpness of the unmagnified image, and the resolving power of the human eye: these are discussed quantitatively for various photographic materials used. Radiographic magnification (of parts of the body which can be completely immobilized) can be taken to ×2 using a focal spot of 0·3 mm. Photographic enlargement of ×2 is possible for radiographs of all body parts taken with a tube whose focal spot is ≯2 mm using non-screen film. The maximum useful linear photo graphic enlargement is at present ×10; this could b improved with faster fine-grain films and more powe ful fine-focus X-ray tubes. Discussion of all points detailed; useful tables compare the properties of film and conditions used; there are many life-size an magnified illustrations, and full references. D. V. MABB

778.33 : 537.54

4547. Indirect autoradiography with a scintillatio counter. C. JECH. *C.R. Acad. Sci.* [*Paris*] **236**, 482– (*Feb.* 2, 1953) *In French.*

A modified form of Rosenblum spark counte similar to that developed by Connor [Abstr. 277 (1952)] is used in conjunction with a photograph plate for determining the position of radioacti material on surfaces. This system has to be operate in darkness. A better form of the apparatus uses thin layer of polystyrene on the cathode and passa of sparks is detected by changes in water condensatio on the surface which can be subsequently phot graphed by normal methods. G. F. J. GARLIC

778.

4548. Direct measurement of particle track length photonuclear emulsion. M. JURIĆ. *Receuil Tra Inst. Rech. Struct. Matière* [*Belgrade*], **1**, 5–10 (*Ju* 1952).

The measuring microscope is modified so that t tube may rotate in the vertical plane about an a parallel to the photographic plate. This enab lengths of tracks which are at an angle 0–30° to t emulsion surface to be measured directly. Allowan has to be made for shrinkage of the emulsio Methods of regeneration to avoid shrinkage by usi glycerine are discussed and it is shown that regene tion can be obtained by soaking in a 10% glyceri water solution. S. WEINTRO

778.

4549. The reduction of distortion in nuclear-resea emulsion. A. J. HERZ AND M. EDGAR. Note in *Pr Phys. Soc.* [*London*] *A*, **66**, 115–16 (*Jan.*, 1953).

A considerable part of the distortion obtained us 1000 micron thick G5 emulsions is shown to occu the "warm" stage of the development cycle. A sea is being made for a developer which can be u satisfactorily at 5°c, thereby minimizing distortion A. C. COA